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AUTHOR Grawe, Roger
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ABSTRACT

This paper explores (on the basis of available data) the role of various family characteristics in fostering abilities in preschool children and the subsequent effect of ability on earnings. The paper is part of an effort to improve the understanding of the process of human capital development as a basic determinant of earnings. Three specific questions are the focus of this paper: (1) What are the characteristics of individuals that significantly affect earnings, and in particular, what is the particular role of ability in generating economic returns? (2) What factors influence the development of abilities in young children? (3) What has been international experience with intervention programs intended to increase the opportunities for children with disadvantaged backgrounds by enhancing their abilities? It is concluded that household income and the status of the mother are key predictors of abilities of preschool children from disadvantaged backgrounds. The extensive appendix contains comments on P. Taubman's "Sources of Inequality in Earnings" and A. Leibowitz's "Parental Inputs and Children's Achievement"; plus, a description of the Gary Income Maintenance sample data with a detailed exposition of results. Statistical tables are included. (RH)

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Ability in Pre-Schoolers, Earnings, and Home-Environment

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ABILITY IN PRE-SCHOOLERS, EARNINGS, AND HOME-ENVIRONMENT

This paper explores on the basis of available data the role of various family characteristics in fostering abilities in pre-school children and the subsequent effect of ability on earnings. The paper is part of the Bank's effort to improve the understanding of the process of human capital development as a basic determinant of earnings. The results suggest that household income and the status of the mother are key predictors of abilities of pre-school children from disadvantaged backgrounds.

Prepared by: Roger Grawe
Development Economics Department

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The World Bank
1818 H Street, N.W.
Washington, D.C. 20433, U.S.A.

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PREFACE

This paper and an accompanying paper by Moshe Smilansky have been produced as part of ongoing work in Population and Human Resources Division of the Development Economics Department and the Education Department to evaluate relative educational investment priorities with respect to different age groups. In view of the increased priority attached to pre-school intervention in recent years, an informal working group within the World Bank was formed to consider whether the pre-school period deserved greater emphasis in its activities in education, nutrition, and health. Foremost among the questions to be considered was the relationship between the timing of the intervention on investment and subsequent productivity. Though little direct longitudinal evidence could be brought to bear, the hypothesis that investments during pre-school years generated outcomes in skills and abilities which themselves subsequently enhanced productivity was considered worthy of investigation. As the Bank is increasingly involved in assisting less-developed countries restructure their educational priorities, an important question was, simply, should more priority be given to the education of disadvantaged pre-school children in an effort to generate a more equitable distribution of outcomes.

To review the evidence on pre-school intervention the Bank invited Professor Moshe Smilansky of Tel Aviv University to participate in a staff seminar in November, 1975. Smilansky contended that the results of pre-school intervention experiments and programs, at least as measured by cognitive tests, were inconclusive at best and did not establish a case for investments priority to the pre-school age category. However, Smilansky noted that the more successful experiments had been those involving the participation of parents. Extrapolating from his experience as an educational policy-maker in Israel, Smilansky proposed that the need, particularly in modernizing societies, is for greater support to the family unit. The most effective target age for such support, he argued, was adolescence. Subsequently Mr. Smilansky was invited by the Education Department and the Population and Human Resources Division to prepare a paper setting out his views. Priorities in Education: Pre-school; Evidence and Conclusions reviews in detail the evidence on U.S. and Israeli experiments in pre-school intervention, and contains an annex which sketches out in a preliminary fashion ways in which greater priority to the needs of adolescents could provide family support.

The paper by Roger Grawe reviews the role of childhood ability as a determinant of subsequent earnings. Grawe then develops some new empirical evidence on the effects of various family characteristics in fostering abilities in pre-school children. This research reinforces, through a quite different methodological route, Smilansky's conclusion that pre-school outcomes can best be enchanced by support to the existing family structure; in particular, Grawe identifies the status of the mother and income as consistent predictors of ability for children from disadvantaged backgrounds.

A significant limitation to the research reviewed and reported by Smilansky and Grawe is its reliance on experience and data from developed economies. This is tempered somewhat by the focus on disadvantaged groups within these economies but generalizations still cannot be accepted. The papers serve to indicate that too little is yet known

concerning the development of intelligence, and its relevance as conventionally measured, to formulate new educational priorities in developing countries. But the weight of the evidence is now that intervention through support of the existing family structure offers the best chance of augmenting the abilities of disadvantaged pre-school children and increasing the likelihood of greater subsequent achievement.

The author would like to express their appreciation to Dov Chernichovsky and Martha Grosse for their detailed comments and assistance in the production of this paper; Susan Cochrane, Mats Hultin, Timothy King, and John Simmons also contributed valuable comments. Of course, none of these individuals are responsible for remaining deficiencies.

ABILITIES IN PRE-SCHOOL CHILDREN: PRODUCTIVITY EFFECTS
AND FAMILY ENVIRONMENTAL DETERMINANTS

Summary, Conclusions and Recommendations

A primary objective of development is to raise the welfare of individuals, by increasing their economic contribution and earning power (and likewise improving non-pecuniary outcomes). Obviously, the expansion of income earning opportunities, by increasing the demand for entrepreneurial and labor services through policies and projects which contribute to general economic growth, is the primary means of tackling this objective. However, individuals themselves have traits and characteristics which also affect their ability to take advantage of and expand the opportunities offered in any economic environment. In order to understand how better to increase and broaden the distribution of welfare-generating outcomes for individuals, it is important to know how individual traits such as schooling and ability affect outcomes, how such traits interact, and how they may be affected by manipulable variables (educational inputs, day care, mother and child health, other forms of family support), and by variables endogenous to the system (income, family structure, labor force participation).

This general formulation leads to three specific questions that are the focus of this paper:

1. What are the characteristics of individuals that significantly affect earnings? In particular, what is the particular role of ability in generating economic returns?

2. What factors influence the development of abilities in young children?

3. What has been international experience with intervention programs intended to increase the opportunities for children with disadvantaged backgrounds by enhancing their abilities?

Section I, which concerns the first question, begins with a description of models of earnings determination and considers some of the statistical problems that complicate empirical verification of the models. An appealing formulation of earnings generation is a recursive model in which the different stages of the model correspond to a life-cycle sequence. However, it is shown that the introduction of greater complexity, for example, the reciprocal effect of child ability on home environment, creates difficult estimation problems in an expanded model. Nevertheless, a review of the evidence indicates that we can identify and measure the impact of ability on earnings.

Section II expands on the particular aspect of the general model which addresses the second question, and is the main focus of this paper. This analysis of the first stage in the recursive earnings model, which relates childhood abilities to family and environmental variables, begins with a discussion of the notion of ability and its measurement. Ability emerges as an operational concept which must be recognized as closely tied to the specific measuring instruments. From this perspective, focussing on a single ability dimension, such as IQ, probably does little to facilitate a better understanding of the issues. Utilizing data from a sample of low income black families in the United States, the relationship between several different pre-school ability measures and selected family background variables is explored in some detail. The results of this analysis show several interesting, though tentative, conclusions. Family income plays a generally significant, and occasionally large, role in the generation of children's

abilities. Also important is the effect of mother's status represented here, either singly or in combination, by marital status, mother's education and employment. The strength of these mother's status effects on a wide range of ability measures suggests that a development activity which enhances the status of women is more likely to improve the capacity and performance of the next generation. Conversely, a development project which has an adverse effect on the status of women is likely, ceteris paribus, to set back the capacity of the subsequent generation. These conclusions are offered with significant caveats: (i) they assume cross-cultural validity between low-income US and LDC environments; (ii) the notion of status is an intervening variable, not directly quantified, and it is, therefore, rather difficult to predict how much status, gained or lost, would result from specific policy measures or would lead to the postulated intergenerational effects.

To begin Section III, some comments are offered concerning the generally negative evaluation of pre-school intervention programs. Methodological and measurement problems are serious enough to cast into doubt broad conclusions from most evaluation efforts thus far. Some recently available longer term evaluations are cited as evidence that the jury must be considered still out on the question of general success or failure of pre-school intervention. In the LDC's, few countries have begun to articulate a policy of support to young children in a family context. However, many countries do have day care programs which could be considerably upgraded if child development objectives were more widely recognized. A review of UNICEF and privately assisted projects indicates some of the potential for effective intervention in LDC's.

On the basis of the issues and evidence discussed in this paper, the following suggestions are offered as directions for future Bank activity in the pre-school area:

1. The Bank should be instrumental in undertaking appropriate studies that will relate abilities to earnings and home environment in LDC's, and thereby enhance our understanding of the process of human capital formation in those countries.

2. Particular consideration should be given to possible research inputs to existing pre-school projects or programs, perhaps on a collaborative basis with UNICEF. This could significantly increase our understanding of the effects of different pre-school environments in the LDC context. A better understanding the curriculums and institutional settings that seem to work for pre-school and early primary children could increase the efficiency of primary education programs.

3. Any effort to monitor the effect of Bank projects on opportunities for women should include the effects on the environment of pre-school children. This would provide a basis for accumulating evidence on the need for and feasibility of specific project components designed to augment the abilities of young children.

SECTION I - Ability as a Determinant of Earnings

This section focusses on the role of cognitive ability in earnings determination. Although there are diverse reasons why social policy might be directed toward augmenting individual cognitive abilities, the primary justification considered here is the effect on the economic well-being and earning power of individuals. 1/ On the basis of evidence from numerous data sets to be reviewed below the following conclusions seem warranted:

1. Developmental or recursive earnings models imply clearly that enhancing the abilities of children will result in higher incomes subsequently. However, empirical efforts to confirm or reject this hypothesis must confront difficult problems of omitted variables, errors in variables, and statistical identification. Nevertheless, the impact of ability on earnings can be demonstrated statistically.

2. The size of the ability effect on earnings varies among data sources, but ranges from small to moderate. There seems to be some evidence that post-school ability has greater direct explanatory power in earnings equations than does pre-school ability, though this is not universally true.

1/ Other reasons for advocating increased cognitive abilities tend to parallel the external effects alleged for education, though I would argue that augmented abilities may have even broader effects. They relate to the technological adaptiveness of populations, and to the level and quality of inter-societal communication (for an economic analysis of the importance of such communication in modern society, see A. Hirschman, Exit, Voice and Loyalty). Non-pecuniary outcomes for individuals due to enhanced abilities (e.g., greater productivity in leisure) and positive cultural effects that a family-oriented ability enhancing program might have, may be quite important in the calculus of individual decision-making though quantification and aggregation problems may reduce their appeal to the policy-maker.

3. The relationship of ability with other determinants of earnings is complex. There seem to be significant interactions between ability and education and between ability and experience, in their joint effect on earnings. Investigations which have allowed non-linear ability effects have been modestly successful.

4. There appears little doubt that childhood ability has considerable indirect effect on earnings through its consistently significant effect on schooling.

The identification of individual characteristics which significantly affect the growth and interpersonal distribution of earnings has only become an important focus of economic research in the past decade. The human capital paradigm has focused attention on a particular formulation of the general issue, an earnings function:

1.1 $$E = F_1(S,T)$$

in which individual earnings are determined by the human capital investments, schooling S, and other forms of training T. Ignoring for the moment specification and estimation problems, the coefficient on S in econometric versions of 1.1 can be interpreted as the rate of return to investment in education. Early objections to this procedure emphasized the likely exaggerated effect estimated for schooling as a result of omitting crucial correlates, particularly ability, from the "independent" variables.

The time dimension over which earnings are measured also significantly influences the relative importance of individual characteristics. Ideally the human capital earnings function should evaluate the determinants of lifetime earnings, since different patterns of human capital investment--

vocational education, university education, on-the-job training--give rise to different earning-age profiles. 1/

These modifications have resulted in a modified earnings function

1.2 $$E_1 = F(S,A,Z)$$

where lifetime earnings, E, are described as a function of schooling S, ability A, and other factors, Z, which may include training and labor-force experience. At this point, the pure investment analogy of human capital breaks down, as it is clear that school and ability have their own determinants which must be recognized and modeled if the earnings function is to be correctly estimated. 2/

One model that has a considerable statistical and theoretical appeal is a recursive system which builds on a life-cycle approach characterized by the initial development of ability, followed by a period of schooling, and finally, entry into the labor force. The three stages of this model may be characterized as follows: 3/

1.3a $$A = F_1(X,G)$$

1.3b $$S = F_2(X,A)$$

1.3c $$E = F_3(X,S,A)$$

1/ Some empirical implications affecting ability will be discussed below. The importance of the earnings-age profile is emphasized in J. Mincer, who has developed the notion of the overtaking point, which occurs when the age earnings profiles of individuals of different schooling cross each other. The profiles differ due to varying rates of personal time preference. The effects of schooling on earnings are greatest at this point.

2/ See Mark Blaug, "Human Capital Theory, A Slightly Jaundiced Survey," Journal of Economic Literature, September 1976, for a discussion of the "investment" model in this context.

3/ Path coefficient models (notably, O. Duncan, "Ability and Achievement," Eugenics Quarterly, 1968) are necessarily based on a similar recursive system.

where

A represents early childhood ability

S, schooling and post-school formal training

E, some measure of lifetime earnings

X, a set of family background characteristics

G, genetic endowment.

As a structural model, these relationships capture some important features of reality, namely that there are distinct developmental stages each focussed on different outcomes which precede chronologically the earnings function. Of course the underlying causal basis of this recursive model is found in the exogenous variables, X and G, of the first equation. The creation of abilities and schooling outcomes are represented only as important processes through which genetic and early environmental characteristics ultimately influence earnings and productivity. In this respect this recursive model presents an extreme case; but its structure offers a useful perspective from which to evaluate the empirical work in this area.

An important implication of the recursive framework is that each of the equations can be estimated singly by ordinary least squares techniques and still yield best, unbiased estimates of the coefficients. In the earnings equation, this has meant that the inclusion of an ability measure has been widely interpreted as allowing the estimation of an unbiased rate of return to education, so that several data sets which include an ability measure have been developed. In a recent review of this literature, A. Leibowitz has presented the salient features of those investigations which

included one or more of the relationships in the recursive model. 1/ This information is reproduced here as Table 1. The variety of data sets and estimation techniques represented in these studies has resulted in a rather heterogenous pattern of results. Of the nine studies reported which include an ability measure, seven find it to be significant predictor of income and the other two find its effects confined to schooling. In all reported studies which investigated schooling attainments, ability figured as a significant determinant. It is important to emphasize that this effect is independent of family background; furthermore only a few of these studies distinguish pre-school ability from post- or mid-school measures.

If, as discussed above, ability is viewed as a developmental concept, then ability and education might be expected to have interactive effects; however, ordinary least squares estimation of the simple recursive model assumes linear independence and additivity between the incremental effects of education and ability. More important the recursive formulation does not permit any feedback of schooling on ability, though such feedback is a clear implication of the developmental approach to ability generation. In more formal terms, assume for the moment that schooling and ability are considered to be proxies for an unobserved variable "productive capacity," P, so that 1.3c becomes, $E = F(P,X)$. Only if this relation is itself linear, i.e.,

1.4 $$P = a_1 A + a_2 S$$

1/ A. Leibowitz, "Family Background and Economic Success: A Review of the Evidence," Law and Economics Center and Department of Family Medicine, University of Miami, mimeo. 1976.

TABLE 1: Outline of Models of Economic Success

Author	Sample	Dependent Variable	Related to	Not Related to	Variance Explained
Bowles and Nelson	1962 Occupational changes in Generation	1962 Income ages 25-34 35-44 45-54 55-64	Schooling 1962 Father's Occupation Education, Income Childhood I.Q.		15% 26%
		1962 Occupation ages 25-34 35-44 45-54 55-64	Schooling 1962 Father's Occupation Education, Income Childhood I.Q. (except age 25-34)		45% 58%
		1962 Schooling ages 25-34 35-44 45-54 55-64	Father's Occupation Education, Income Childhood I.Q.		41% 47%
Chamberlin and Griliches	Gorseline 156 pairs of brothers	1928 Income in Indiana	Schooling "Ability" Age		
		1928 Occupation	Schooling "Ability" Age		
		1928 Schooling	Age	"Ability"	
Conlisk	Berkeley Guidance Study 75 men	1960 Earnings (age c.30) (est from occupation data from 1960 Census)	Schooling (age 30) Parents' Income (1928-29)	I.Q. (ages 1-18) Parents Schooling Number of own children	43%
		Schooling (age 30)	I.Q. (ages 1-18) Parents' Income	Parents' Schooling	44%
de Wolff, Van Slijpe	1938 Students in Malmo, Sweden 545 men	1963 Taxed Income	Schooling Social Class Childhood I.Q. (I.Q. and Social Class Interaction)		33%
Duncan	1962 Occupational Changes in a Generation; 1964 CPS	1964 Earnings men aged 25-34	1964 Occupation Adult I.Q. Education Father's Education	Number of Siblings Father's Occupation	11%
		1964 Occupation	Education Father's Occupation Adult I.Q. Father's Education Number of Siblings		28%
		Education	Childhood I.Q. Father's Occupation Father's Education Number of Siblings		42%

Source: A. Leibowitz, "Family Background and Economic Success: A Review of the Evidence," Law & Economics Center and Department of Family Medicine, University

Table 1 cont.

Author	Sample	Dependent Variable	Related to	Not Related to	Variance Explained
Leibowitz	Terman Sample 700-784 obs. males 615 females	1940, 1950, 1960 Earnings (age 29, 39, 49)	Schooling Experience Family Income (1940 and 1950)	Mother's Schooling Father's Schooling Childhood I.Q. Family Income (1960)	6% 10%
		Schooling 1940, 1950 males	Mother's Schooling Father's Schooling Childhood I.Q. Siblings (in 1940)	Time Inputs in Early Childhood Siblings (1950) Family Income	8% 10%
		Schooling 1940, 1950 females	Mother's Schooling Father's Schooling Siblings Birth Order	Childhood I.Q. Family Income	17% 15%
		Childhood Ability I.Q. at c. age 11 males	Mother's Schooling Birth order Time inputs to child Family income	Father's Schooling	19%
		Childhood Ability I.Q. at c. age 11 females	Family Income	Mother's Schooling Birth Order Time inputs to Child Father's Schooling	13%
Lindert	312 New Jersey executives 1008 observations	1963 Schooling age 31-81	Mother's Schooling Father's Schooling Father's Occupation Broken home Birth order No. of siblings Estimated Time Inputs	Age Sex	32% across siblings 8% between siblings
		1963 Occupational Status of 659 Males	Father's Schooling Father's Occupation Broken home Age Birth Order No. of siblings Estimated Time Inputs	Mother's Schooling	27%
Morgenstern	1968 Urban Problem Survey 842 blacks 782 whites men and women	1968 Average yearly Wage Rate	Schooling Experience Father's Schooling Sex School Quality for Blacks	School Quality for Whites	24% 27%
		Schooling 1968	School Quality Region Mother's Schooling Father's Schooling Sex Age		21% 30%

Source: A. Leibowitz, "Family Background and Economic Success: A Review of the Evidence," Law & Economics Center and Department of Family Medicine, University of Miami, mimeo 1976.

Table 1 cont.

Author	Sample	Dependent Variable	Related to	Not Related to*	Variance Explained
Sewell and Hauser	Wisconsin Study 2069 men	1967 Earnings (age c.29) (from Social Security)	Schooling Ability Occupation 1964 Parental Income (1957-1960)	Father's Schooling Mother's Schooling Father's Occupation	7%
		1964 Occupation measured by Duncan SEI	Schooling Ability Father's Occupation	Father's Schooling Mother's Schooling Parent's Income	41%
		Years of Schooling	Measured Ability Father's Schooling Mother's Schooling Father's Occupation Parents' Income		28%
		Measured Ability	Father's Schooling Mother's Schooling Father's Occupation Parents' Average Income		9%
Taubman	NAS-NRC	1973 Average Income of twins	Av. Schooling Father's Schooling (MZ) Mother's Schooling (DZ) Hours Disability Status Self Employment Status Jewish Religion Catholic Religion (DZ twins only) Age (DZ)	Mother's Schooling (MZ) Father's Schooling (DZ) Age (MZ) Government Employee Other Religion	37% (MZ) 38% (DZ)
		1973 Income Difference between twins	Difference in Schooling Self Employment Status Government Employee (DZ) Disability Status (MZ) hours (if self employment, government status not included)	Government Employee (MZ) Disability Status	5% 12%
Wachtel	NBER - Thorndike 1812 men aged 44-52	1969 Income	Schooling Log of Hours Ability College Quality School Quality Experience Father's Education	Siblings Mother's Education	19%
		Schooling	Ability Siblings Father's Education Mother's Education Age	School Quality	10%
		Ability 1943	Mother's Education Father's Education School Quality		3%

Source: A. Leibowitz, "Family Background and Economic Success: A Review of the Evidence of Family Medicine, University of Miami, mimeo, 1976.

will the linear form of the recursive system (1.3) adequately account for the education-ability interaction. 1/

Recognizing that pre- and post-school abilities may vary, captures one aspect of this interaction. For example, let A_1 and A_2 refer to pre- and post-school abilities respectively, and consider the model:

1.5 $$A = g_1(X,G)$$

1.5b $$S = g_2(X,A_1)$$

1.5c $$A_2 = g_3(A_1,S)$$

1.5d $$E = g_4(A_2,S,X)$$

If this model correctly described reality but were specified incorrectly by an econometric version of the simple recursive model (equations, 1.3, above) it can be readily demonstrated that the estimated effect of schooling would reflect the product of the marginal effect of post-school ability on earnings and of schooling on post-school ability, while the real effects of schooling

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1/ F. Welch, op. cit. demonstrates that with such a linear specification and plausible parameter estimates for the first order partial correlation coefficients $r_{ps.a}$ and $r_{pa.s}$ result in an interpretation of the schooling coefficient not as a rate of return but as itself a much better estimate of the incremental importance of "true" ability or productive capacity.

and post-school ability on earnings would be weighted components of the estimated coefficient on pre-school ability. 1/

An alternative form of 1.5d still consistent with a recursive formulation is

1.6 $$E = g_4'(X, A_1, S, A_2)$$

An appealing transformation of this general form would be

1.7 $$E = h_1(A_1)h_2(X, A_2, S)$$

in which early childhood abilities could have the effect of an efficiency parameter augmenting the effects of schooling, post-school abilities, and other background factors. This particular version of the earnings function might be particularly appropriate if A_1 were considered to be a vector of pre-school outcomes which could not be subsequently made up. This might

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1/ Consider economic formulations of 1.3 and 1.5:

1.3a′ $$A = a_{11}X + a_{12}G + U_1$$

1.3b′ $$S = a_{21}X + a_{22}A + U_2$$

1.3c′ $$E = a_{31}X + a_{32}S + a_{33}A + U_3 \quad ;$$

1.5a′ $$A_1 = b_{11}X + b_{12}G + e_1$$

1.5b′ $$S = b_{21}X + b_{22}A_1 + e_2$$

1.5c′ $$A_2 = b_{31}S + b_{32}A_1 + e_3$$

1.5d′ $$E = b_{41}X + b_{42}S + b_{43}A_2 + e_4 \ .$$

Suppose that 1.3c′ is estimated even though model 1.5 better reflects reality. In this case substitution illustrates that the estimated coefficients a_{32} and a_{33} will actually equal

$$a_{32} = b_{43} \cdot b_{31}$$

$$a_{33} = b_{42}b_{22} + b_{43}b_{32}$$

Model 1.3 in effect, a semi-reduced form version of the structural model, 1.5; as such it must be recognized that the coefficients have no direct interpretation.

be particularly appropriate for children in multiply disadvantaged environments, in which brain development might be permanently set back through malnutrition or mental growth inhibited through the lack of environmental stimulation at appropriate times in terms of brain development. 1/ In such cases the function, h_1, might be of the form,

$$h_1(A_1) = (1,\theta)$$

where $\theta < 1$ obtains only in the case of compounded or severe deprivations. In the normal case, the effects of early childhood ability work themselves out indirectly through earlier stages in the recursive framework (i.e., $h_1(A_1) = 1$). The formulation of 1.7 is merely one specification of many in which interactions between ability and other variables contribute to economic performance; but it does summarize usefully the developmental plausibility of these sorts of interactions.

Turning again to the empirical studies summarized in Table 1, one notes that few have had the required data or were organized so as to explore fully the types of interactions that might be expected. In general the inclusion of ability measures in earnings functions has been found to reduce schooling coefficients in the range of 4 to 35% with a central tendency around 10%. 2/ Post-school ability measures seem to be associated on average

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1/ Herman Epstein, a physiological psychologist at Brandeis University, has presented some very suggestive evidence on these points in an informal seminar at the World Bank. His research indicates the existence of developmentally significant growth spurts in brain size which seem to be highly correlated with mental growth. These spurts occur at approximately two-year intervals until adulthood; but deficits caused by early childhood malnutrition do not appear to be made up subsequently.

2/ H. Gintis, "Education, Technology and the Characteristics of Worker Productivity," American Economic Review, 61 (May, 1971), reviews nine studies which yield results within these bounds. Subsequent studies seem to narrow this range: Griliches and Mason (7-10%), Taubman and Wales (9%). Negligible effects of pre-school ability on the education-income relationship were found by both Conlisk and Leibowitz, however.

with larger reductions in the schooling coefficient, between 15 and 20%, providing some indirect evidence for the specification of a developmental theory in which abilities at different stages are treated differently. 1/

Explicit evidence of interaction effects between education, experience, and ability is provided by J. Hause in a reanalysis of several data sets stratified by labor force experience and educational level.

> The data ... imply that measures of cognitive ability are associated with an empirically significant but modest increase in annual earnings for those with high levels of schooling ... In the United States samples, there appears to be a distinct tendency for the ability coefficient to increase with labor force experience. 2/

In the four data sets reanalyzed by Hause the ability coefficients at the highest educational levels (either one or more college degrees) range from 1.65 to 7.7 times as great as the ability coefficients on the lowest education levels (high school dropouts) with the variation in the range related to both the type of ability measure and the age of the cohort. The greater the age (experience) the larger the ability coefficients in all educational strata; but those in the highest educational levels increased relatively more. An interesting dimension of Hause's results that he does not elaborate

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1/ Griliches and Mason established a post-school reduction in the schooling coefficient of 13-17%. Hanushek in a study not reported in Table 1 ("Teacher Characteristics and Gains in Student Achievement: Estimation Using Micro Data," American Economic Review, 61 (May 1971)), found a bias of 15% in the schooling coefficient on earnings when post-school ability was uncontrolled. Taubman and Wales' data and estimation techniques yield a range between 10% and 19%.

2/ J. Hause, "Ability and Schooling as Determinants of Lifetime Earnings," in F. Juster, ed., Education, Income and Human Behavior, Carnegie Foundation For the Advancement of Teaching and National Bureau of Economic Research, 1975.

is the tendency for ability coefficients for both high-school and college dropouts to be significantly lower than for those for high-school and college graduates. This presumably indicates the interaction of ability with some sort of motivational factor. In terms of the model suggested in 1.7 this motivational dimension may figure as a component of the background factors, X; or it may be that the ability outcomes themselves include non-cognitive components.

Further evidence on interaction is provided in another data set (the National Bureau of Economic Research--Thorndike data) extensively analyzed by P. Taubman. 1/ Ability tests were administered during World War II as part of the qualifying process for pilot selection in the Air Force. Earnings profiles were subsequently obtained in 1955 and again 1969. Taubman finds strong ability effects: the increment to earnings in both years associated with the difference between the top and bottom fifths in the ability distribution exceeds the earnings increment associated with a bachelor's degree. 2/ Taubman tested for interactions in the most general functional form by computing separate earnings equations for each ability fifth. He concludes "using analysis of covariance, we could not reject the hypothesis that the effects of all variables including education, were independent of

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1/ P. Taubman, Sources of Inequality in Earnings, North Holland Publishing Co., Ltd.; Amsterdam, Oxford; 1976.

2/ Taubman uses ability fifths from one factor of the raw scores as his ability measure. As the test population had already scored above the median on a general intelligence test, Taubman notes that his fifths correspond more closely to tenths in the general population.

the level of ability in each year." 1/ However, Taubman does find significant differentials between the bottom ability fifth and the top four fifths with successively greater effects even within the top four fifths. These non-linear effects of ability are more pronounced in 1969 than in 1955, and supplement across-the-board increase in ability effects in the later year. One may conclude from Taubman's empirical analysis that ability interacts non-linearly with age or experience in affecting earnings (though, at least as measured in the NBER--Thorndike data, ability does not interact with education and other determinants of earnings).

Finally, Leibowitz reports two additional pieces of evidence on ability interactions. One, an extensive study by Sewell and Hauser, 2/ analyzes an early career profile of earnings in a large sample of the cohort of 1957 high school seniors in Wisconsin. Both ability-education and ability-experience interactions were well documented. The second is the Swedish study by de Wolfff and Van Slipje who "found that intelligence and social class reinforce each other in generating earnings, and their combined effect, particularly at high levels of education, is much greater than implied by an additivity of effect." 3/ The Swedish data on social class and ability were

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1/ Taubman, op. cit., p. 34. Note that this finding does not preclude that a continuous scaling of ability with the stronger assumption of a functional form such as 3.3 might not yield significant interactions coefficients. Furthermore, Taubman's ability is a post-schooling measure which might itself be thought of as the outcome of a schooling--pre-school interaction. Under this interpretation, the independence of education and ability lends some support to the Gintis-Bowles hypothesis on education as a proxy for non-cognitive outcomes (cf. S. Bolwes, H. Gintis, and J. Simmons)

2/ Sewall, W. H. and Hauser, R., Education, Occupation and Earnings: Achievements in the Early Career. New York: Academic Press, 1975.

3/ A. Leibowitz, op. cit., p. 20.

collected in 1938 and income, 25 years later in 1963. One might rationalize ex-post that the behavioral correlates of social class would have been much more homogenously grouped in Sweden of 1938 than today; also an investigation of ability-education interactions stratified by SES levels would have been informative.

Another important aspect of the relationship between ability and earnings is the indirect effect through the influence of ability on schooling. In terms of the evidence presented in Table 1, all of the studies which had a direct ability measure among the determinants of schooling found the relationship to be significant. 1/ It is also generally true that the variance explained in the schooling relationships is greater than in the earnings function, so that the indirect effects of ability may often exceed the direct effects in actual dollar impact on earnings (this obviously depends specifically on the relative sizes of the various coefficients involved; but, in general, the effects of ability on schooling and schooling on earnings are both rather large while the direct effect of ability on earnings though often sigificant is not usually large).

Some of the problems in sorting out the effects of schooling and ability have already been mentioned above. These became further compounded as one takes a more generalized view of schooling and ability outcomes. If abilities are defined to include non-cognitive outcomes as well as a broad range of cognitive skills, and schooling outcomes consist of learned knowledge

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1/ The single exception, the study by Chamberlain and Griliches, infers an ability measure from a components of variance model estimated on a sample of brothers. Whatever skills are represented by this ability measure are a significant determinant of adult earnings and occupation but not schooling.

as well as work habits, attitudes, etc., then a system with feedback is needed to portray the types of interaction that presumably occur:

1.8a $$A_t = h_1(X_t, S_t, G)$$

1.8b $$S_t = h_2(X_t, A_t)$$

1.8c $$E_t = h_3(A_t, S_t, X)$$

where the subscript t refers to time. In this variant schooling and ability interact as determinants of each other at any given point in time. Once the interaction is admitted the practical benefits of the recursive system are lost and it is no longer possible to estimate unique coefficients for the variables in the various equations. In terms of an econometric model, only the schooling relationship can be estimated without further restrictions. Neither the ability nor the earnings equations can be identified. This raises serious doubts about the consistency of single equation estimates of the earnings function (1.8c) which do not explicitly deal with the econometric effect of the schooling-ability model.

Alternatively one may specify a model which combines the simultaneity features of "1.8" and distinguishes pre- and post-school ability as "1.5" above. In this case the pre-school ability equation can be identified and estimated with standard techniques even though the simultaneity

difficulties remain in the the rest of the model. 1/ The next section of this paper deals specifically with the determinants of pre-school ability. 2/

1/ This model may be specified as follows:

1.8a′ $A'_t = h_1(X_t, G)$

1.8a $A_t = h_2(X_t, S_t, A'_t)$

1.8b $S_t = h_3(X_t, A_t)$

1.8c $E_t = h_4(X_t, A_t, S_t)$

In this formulation the pre-school ability equation combines the structural and reduced forms and can be estimated using standard regression techniques. It should be noted that were adequate longitudinal data available, the inclusion of "previous period" ability and schooling outcomes in the ability and schooling equations would result in an indentifiable structure.

2/ Of course, the ability-earnings relationship is not even a necessary condition for policies to augment the abilities of young children if other than economic goals are considered as policy objectives. In Tanzania and Peru, for example, day care programs for young children are justified as an important element in the restructuring of rural society: this as much for their role in socializing future adults as for their cognitive value (though the latter is more explicitly recognized in Peru). Or intervention may be reasonable widespread as in the provision of day care in Kenya but remain a privately demanded and supplied service with little government direction or support.

SECTION II - Family-related Determinants of Ability in Young Children

In Section I a general model of the development of individual economic performance was developed in which ability plays an important role first as an outcome in its own right and then as an important determinant of schooling and earnings. In the present section, attention is focussed on the determinants of ability and, in particular, of pre-school ability. The general model for the discussion is

2.1 $$A_t = F(X_{it}, G)$$

where At represents a vector of ability outcomes at time t, X_{it}, a set of i environmental characteristics, and G, genetic endowment. The discussion will first take up some issues in the definition and measurement of ability. A brief discussion of heritability will follow. The main part of the section will present and evaluate empirical evidence on the environmental determinants of ability.

The Measurement and Meaning of Ability

Ability is an operational concept: in the context of the present model, ability is the intervening variable that relates a set of family background characteristics to subsequent individual performance in school and work. The practical validity of this concept depends crucially on the specific instrument that is to measure ability. Traditionally cognitive ability measures were designed to predict school performance, usually within a short to medium time horizon. The instruments that were to be designed for this objective were selected on certain characteristics. As school performance is, by design, a relative concept with a near normal distribution, the standard

cognitive ability measure should generate over similar populations a similarly normal distribution. Furthermore as school performance does not, on average, fluctuate dramatically from year to year, a predictive measure was desired which demonstrated similar stability. Finis Welch has pointed out that these objectives will logically result in the development of ability measures which are heavily influenced by the more stable set of underlying factors, such as home environment. 1/ Furthermore a test which reflects predominantly characteristics of middle-class home environment will also tend to the desired normal distribution. It is natural then that IQ tests will tend to be less reliable over longer periods of time as the background characteristics themselves will tend to vary more. The phenomenon reported by Bloom in Stability and Change in Human Characteristics, namely that "in terms of intelligence measured at age 17, at least 20% is developed by age 1, 50% by age 4, 80% by about age 8, and 92% by age 13," 2/ is attributable to (i) the increasing sensitivity of the intelligence test to the more stable elements in the background of the individual, and (ii) to the increased probability of stability in the determinants of test response. The latter is itself due to simply the shorter span of years involved and the resulting lower likelihood of significant changes in the environmental determinants of ability and, I would speculate, to the increasing feedback effect of the individual on his own environment, thereby increasing the stability of that environment.

1/ F. Welch, "Relationships between Income and Schooling" in Review of Research in Education, 2.

2/ This statement forms the basis for an illuminating discussion by M. Selowsky, "A Note on Pre-School Age Investment in Human Capital in Developing Countries," in Economic Development and Cultural Change, Vol. 24, No. 4, July 1976.

In the following discussion, the term ability will refer to a variety of specific instruments, though most are variants of "IQ." Each of these tests was designed for a specific evaluation or predictive purpose which was not directly related to the general earnings model. In the case of cognitive measures, such as IQ, we know that they do relate to subsequent outcomes, particularly school performance, but also earnings. In the case of non-cognitive, or affective, measures, the primary objecives of the tests have been short-term evaluations for counseling purposes. Given such objectives it is not surprising that affective tests have shown little stability in the context of long-term models. Few would dispute that affective traits play a crucial role in determining economic performance, but little progress has been made in devising the measures with which such traits could be identified. In the empirical treatment of outcomes for pre-school children to be presented below, affective outcomes will be used to supplement information on cognitive outcomes.

One disclaimer to this discussion of ability measure should be noted. This review, and the subsequent discussion of empirical results do not discuss the issues posed by the ongoing but seemingly sterile debate on the heritability of IQ. There now exists a comprehensive literature on this matter which has demonstrated conclusively the inadequacy of the data (some of which has now been shown to have been fabricated), and of the statistical procedures that have been utilized to demonstrate heritability coefficients. 1/ Even more to the point is the fact that heritability estimates of any trait

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1/ See L. Kamin, The Science and Politics of IQ, Halstead Press, New York, 1974, and A. Goldberger, Discussion Papers Nos. 225-74, 242-74, 301-75, 340-76, 341-76, Institute for Research on Poverty: University of Wisconsin, Madison.

are population specific. Such estimates do not establish relative heritability characteristics between distinct genetic pools; nor do they establish anything concerning the relative heritability of traits within populations having quite different environmental characteristics. As the objective of this exercise is to identify policy issues which may relate to the pre-school populations of disadvantaged groups in developing countries, the heritability of IQ within samples of relatively affluent American and British populations can only establish an upper bound which is likely to be of little relevance in rapidly changing LDC environments. The dominance of gross changes in environment over heritability has been effectively demonstrated in the case of anthropometric measures such as weight and height. 1/ However, in the discussion of empirical results it must be borne in mind that without an explicit control for the genetic component of the ability measures, the coefficients on other determinants will be biased to the extent they are correlated with genetic factors.

The empirical results of this section focus on the determinants of abilities in children, particularly pre-school children. Three such studies are summarized in Table 2. What conclusions may be drawn from these investigations?

1. The first and most basic point is that systematic effects of family characteristics occur both in samples that range widely over socio-economic strata and in a sample that is confined to poor and lower middle-income blacks. In particular mother's education and family demographic characteristics appear as significant determinants.

2. New information emerges from these studies on the relation of mother's education to other significant

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1/ See, for example, G. Graham and B. Adrianzen, "Growth, Inheritance, and Environment," Pediatric Research 5 (1971); and J. Halricht et. al "Height and Weight Standards for Preschool Children - How Relevant Are Ethnic Differences in Growth Potential?" The Lancet April 6, 1974.

Table 2: ENVIRONMENTAL DETERMINANTS OF CHILDHOOD ABILITIES

Study	Ability Measures	Sample Characteristics	Type of Test	Significant Determinants
(1)	(2)	(3)	(4)	(5)
Taubman	Pilot qualifying test scaled sub-test	Post-high school--upper half of ability distribution nationwide	Cognitive/ Achievement	(1) Mother's education, (2) Biography variable (a composite of education and family socio-economic status, (3) Sociological factors (Jewish upbringing, raised by grandparents-negative) (4) Affective or motivational elements: (financial motives in occupational choice, date marriage, self-employment, perceived financial pressure)
Leibowitz	Peabody picture vocabulary	Preschool visions of "Sesame Street" Rural & Urban samples of all SES	Cognitive	(1) Family size, (2) Mother's education, (3) Labor-saving consumer durables, (4) Presence of encyclopedia (5) Joint mother-child activities--e.g., reading together, (6) Mother's TV watching - negative.
Grawe	Seguin form board	Preschool participating families in Gary, Indiana income maintenance experiment	Visual/Motor skills	(1) Child spacing, (2) Female-headed household, (3) Mother's education, (4) Labor-force participation of family head, (5) Income and charges in income.
	Preschool inventory (PSI) Role Identification (ROL) Brown referent scale (Self-concept) (BRN) School readiness ("Gumpgookies") (GMP)	-	Cognitive/ Socio-emotional	(1) Earned income - PSI, ROL (2) Labor-force participation - GMP, BRN (3) Family size negative - GMP, BRN (4) Child spacing - GMP, BRN (negative) (5) Increased transfer payments - negative.
	Wechsler Preschool & Primary Scale of intelligence Subscales: Arithmetic (A) Block Design (B) Comprehension (C) Picture Completion (P)	-	Cognitive (IQ)	(1) Birth order, (2) Child spacing, (3) Change in earned income, (4) Female-headed (I) household (5) Level of monthly income (B, C)

Table 2 cont.

MNEY	$/100	2.50 (3.07)	Average monthly income earned by all family workers in 1972.
MNEYSQ	$(\$/100)^2$	15.65 (25.91)	The square of MNEY
MNUY	$/100	2.80 (1.79)	The average of all unearned income received monthly by the family including all forms of welfare payments, the net value of food stamps, social security payments, etc. during 1972.
MNTPY	$/100	1.08 (0.98)	Average 1972 monthly transfer payments received by families in the treatment groups of the Income Maintenance Experiment.
DMNEY	$/100	0.11 (1.58)	The change in average monthly earned family income between 1972 and 1973.
DMNUY	$/100	-1.74 (1.44)	The change in average monthly unearned income between 1972 and 1973.
DMNTP	$/100	0.51 (0.88)	The change in average monthly experimental transfer payments between 1972 and 1973.

determinants. From the Leibowitz data, there appear to be strong indications that mother's education matters because of the activities that educated mothers undertake with their children (reading, not watching TV, etc.). The Gary Income Maintenance data broaden the picture to include factors other than education which may serve to increase the status of the mother, such as heading the household and participating in the labor force. Each of these factors was found to contribute to specific types of childhood abilities, giving a somewhat broader picture of the importance of the mother-child relationship.

3. Controlling for the status variables, one may generalize that income has a significant impact on abilities in a sample of predominantly low income black American children. There is some reason to believe that for some abilities (including both cognitive and affective traits) the significance of income or changes in income dominates the effect of mother's education at least within the ranges of income less than $15,000 a year and education of high school or less as covered by the Gary sample. There is some evidence that income plays a more significant role in families in which the mother is less well-educated.

4. Demographic effects are mixed: there does seem to be a general detrimental effect on abilities from close child-spacing, particularly in two-parent families or families having a relatively more educated mother. There does not, however, appear to be a consistent pattern to the effects of birth order. In the Leibowitz sample, family size does consistently have the predicted negative effects on ability. The fact that this is not the case in the Gary sample suggests that family size effects might be related to broader socio-economic distinctions. Child-specific variables (birth order, spacing, age) do interact with mother's education and family status. Thus test scores standardized by age, for example, may fail to reflect accurately environmental influences.

5. Finally, the Taubman post-high-school data suggest, through the significance of the general "background" variable, important feedback effects of schooling on ability confirming the simultaneity problems discussed in Section I. The Taubman data also indicate the importance of sociological and motivational factors though the direction of causality for the latter is far from clear.

The following discussion will summarize the most important results across the various ability measures first in the Taubman and Leibowitz

studies and then in the Gary sample, leaving a detailed description of the outcome measures and the specific explanatory variables and a test-by-test discussion of results to the Appendix.

In a study that involved mid-school (as opposed to pre-school) abilities, Taubman estimated a variant of the ability function 2.1. The ability measure was a post high school qualifying test given to candidates for pilot training during World War II. Of the many sub-tests, Taubman constructed a scaled score predominantly reflecting skills in numerical operations, mathematics, and reading. Although the sample size allowed quite detailed estimation using nearly fifty independent variables, the explained variance in the ability scores barely exceeded 8%. Taubman's results indicate strong effects of parental education; but a single interpretation does not readily follow as there is no family income variable among the background measures. The effects of parental education may be interpreted as reflecting (i) the genetic endowment of the parent, (ii) actual earnings, or (iii) non-income related and otherwise unmeasured aspects of the home environment. On the basis of the low labor force participation rates reported for mothers in his sample, Taubman argues for an interpretation based on (i) and (iii); but this reasoning cannot exclude a family income-related interpretation as assortive mating could lead directly to the interaction of (unmeasured) family income and mother's education.

A. Leibowitz has analyzed a set of data for which the ability measure relates to the pre-school period. Using scores on the Peabody Picture Vocabulary Test as the outcome measure, A_t, she estimates the effect of a reasonably rich set of home environment variables. In particular she finds significant effects from family size, mother's education, the presence of

labor-saving consumer durables (dryer and dishwasher), the presence of an encyclopedia, and joint mother-child activities, such as reading. However, the work status of neither the mother nor father was found to have a significant effect on pre-school verbal ability, nor did the presence of consumption-oriented durable goods (TV, HiFi), nor attendance at day care, Head Start, or kindergarten. Children of mothers who watched TV regularly when the child was present did score significantly lower.

The data analyzed by Leibowitz allowed a breakdown into urban, suburban, and rural subsamples. Among the urban families, the effect of mother's education was considerably weaker, as were the various activity effects. However, the presence of labor-saving or education-related goods had considerably greater effects. In contrast, only the reading activity variable was estimated to have a significant effect among suburban families; while in the rural sample, mother's labor force participation had a strong negative effect (which, however, was halved by accounting for TV watching). Family size was not related to the ability measure in either the suburban or rural samples. These differential effects seem to illustrate that the specific activities which mothers engage in affect the human capital acquisition of their children as much or more than gross measures of socio-economic status or time spent with children.

The most important class of variables that emerge from analysis of the Gary Income Maintenance data concerns the effect of mother's status on child performance. Mother's status in the context of these families is reflected in education, heading the household, and participating in the labor force. The effects of this class of variables is strongest on visual-motor skills as measured by the Seguin Form Board and the Block

Design sub-test of the Wechsler Primary and Pre-school Scale of Intelligence. Since a major developmental focus of the pre-school period is physiological maturation, the coordination of motor skills with cognitive ability assumes considerable importance (arguably greater than pure cognitive effects). The interaction of mother's status with other variables indicates more how the status variables operate. This analysis suggests a degree of substitutability between mother's education and single parenthood in their effects and ability whereas labor force participation and single-parenthood (synonymous with female headed households in this sample) appear to have complementary effects. 1/ There is also some indication in the covariance analysis that earned income and regular employment may substitute for mother's education. On a limited scope of outcomes, it appears that labor force participation among less educated mothers hinders performance. In the affective domain, the major differential effect is that of labor force participation in female-headed households--a result consistent with the importance attached here to the status of the mother. There is some indication that child-specific characteristics as age, birth order, and spacing lose their normal importance as ability determinants in female-headed households.

The second major category of variables which were included in the investigation of the Gary data were income-related. In the context of the income maintenance experiment it was possible to distinguish between sources of income (earned, unearned, experimental transfer payments) 2/ and

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1/ In the case of two sub-tests on the IQ measure some puzzling reversals of the general propositions on mother's status occurred. Single parenthood was found to enhance the effect of the better-educated mother.

2/ Unearned income generally consisted of governmental transfer payments other than the experimental payments.

to specify changes in average monthly income between the two years during which the study was conducted. Also related to this category were measures of the frequency and duration of employment.

In general, earned income significantly affects a broader range of abilities than income from other sources. In particular, higher levels of earned income enhance the performance of children on the visual-motor skills and on cognitive measures which have a significant informational component. In the case of the latter measures there does seem to be a significant topping-off effect to earned income, with the overall income effect negative at very high levels (relative, of course, to the sample mean). 1/ Increases in earned income have consistently positive effects over the all IQ sub-tests that were used in the sample as well as on a "self-concept" measure. The effects of increments in earned income are significant but much weaker in the case of visual-motor skills. The policy significance of direct income effects in this sample of low income urban blacks is great, for it indicates that within a disadvantaged socio-economic stratum, controlling for education and family structure, better performance in the economic system generates better outcomes for young children.

The results presented here do not allow a precise specification of the means by which income affects performance; the major alternative interpretations would seem to be related to (i) increased allocation of goods

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1/ This effect can best be interpreted as sample-specific, i.e. within the restricted range of income-earning opportunities available to families in the Gary sample, those at the high range had made in some sense, extraordinary efforts with sacrifices in other dimensions in order to attain incomes which for the population as a whole would not be considered high.

to young children or simply the presence of a materially more stimulating environment, (ii) a more achievement-oriented environment, stemming from the greater motivation of the income earner, (iii) the greater security and stability implicit in a wage-earning environment, though this effect should be controlled by the labor force participation status of the household, or (iv) residual effects of genetic endowment, parental intelligence, not captured elsewhere (in a sample for whom educational opportunities may have been arbitrarily limited, these effects may be plausibly proxied, at least in part, by income).

Earned income also interacts systematically with other determinants of ability. In particular, there is evidence from several ability measures that earned income effects are greater for children with less educated mothers. This lends support to the productivity rationale for income effects or suggests that whatever income buys may act as a substitute for mother's education. In one case, income effects are stronger among children who respond more readily to the test situation. 1/ This sort of interaction is indicative of the basic identification problems that result from the feedback between the child's own development and the environment that further stimulates that development. The interaction between single-parenthood and earned income is inconclusive. On some outcome measures performance is significantly reduced by increases in earned income in female-headed families while on other measures income has positive effects.

1/ In all the various tests of pre-school children in the Gary sample, a minority of 10-15% refused to respond at all to the test. This statement is based on separate regressions which were computed for the subgroup of responders.

The role of unearned income and experimental transfer payments is much spottier. In the few cases in which experimental payments emerge as significant determinants they seem to behave in a complementary fashion to earned income and in the direction opposite to other unearned income. The implications of this are provocative in the context of redistributive policy; but the actual results are too thin to support more than speculation. The major implication relevant to LDCs is the importance of earned versus unearned income.

A final set of explanatory factors that bear importantly on childhood ability includes demographic factors such as birth order and child spacing. 1/ Within the rather narrowly defined socio-economic group that constitutes the Gary Income Maintenance sample, there emerge few consistent patterns to demographic effects across tests. This heterogeneity seems mainly due to differential demographic effects within different family types or different education strata.

The negative effects of birth order on performance were, with one notable exception, concentrated in two-parent families. The magnitude of significant birth-order effects was not exceedingly large, however: the differential due to a single position later in the sibling order varied from the equivalent of three to seven months in maturation. In some cases a significant, positive birth order effect occurred within single-parent families indicating, perhaps, some substitution of older siblings for the second parent in fostering certain skills (visual/motor skills in particular). In

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1/ In the Gary sample, preliminary investigations determined that the number of children in the family had no explanatory power, except as a proxy for birth-order.

all sub-scales of the WPPSI-IQ test the positive effects of birth order within the sub-group having high-school or better educated mothers dominated the full sample. One can only speculate as to why this effect should occur in the restricted domain of the IQ tests. A plausible but by no means certain explanation is that older children attending school particularly enhance the abilities of younger siblings in families which value and support education as proxied by the mother's education.

The second demographic dimension that is investigated in some detail in the Gary sample is the effect of close child-spacing. On balance, a narrow gap between the subject child and his next oldest sibling retarded performance; if the gap were less than one year the decline in performance was often substantial, exceeding a standard deviation for some subgroups. These effects are again most consistent on the WPPSI-IQ measure for children whose mothers attained at least a high school education. This is at least consistent with the rationale offered above for the positive birth order effects in such families since close child spacing would vitiate the hypothesized cognitive stimulation of the older sibling who would not be sufficiently advanced in school. Negative child-spacing effects are also found in the non-cognitive school-readiness measure particularly for children in two-parent families in which an interval of less than 1 year with the next oldest sibling retarded performance by over 1.3 times the sample standard deviation of the test score. It should be noted that, anomalously, in the case of some visual skills and the self-image measure, close child-spacing actually facilitated performance in two-parent families.

On the whole, demographic effects on child performance in this sample do not reveal clear-cut patterns. One may conclude only that the

standard negative effects associated with child order and spacing cannot be assumed to hold for all disadvantaged groups. It also seems clear that effect of family size or spacing can be expected to vary with particular outcome or ability measures.

SECTION III - Pre-school Intervention

The previous two sections have examined in detail the role of ability in the modeling of earnings determination and the factors which themselves contribute to different childhood abilities. In the present section some comments are offered on the evaluation of intervention programs designed to improve pre-school abilities and on the prospects for organizing operationally-oriented research on these issues in LDCs.

Numerous detailed reviews of the literature on compensatory education for pre-school children have been completed in the past four years. The accompanying paper by M. Smilansky 1/ reviews in detail most of the experiments and special projects in compensatory education conducted during the late sixties and early seventies. Smilansky's conclusions are similar to those of other reviewers, such as U. Bronfenbrenner 2/ in stressing the ephemeral gains produced by most well-designed intervention projects (ill-designed projects do not generally produce even ephemeral gains, though many different curricula have been found effective so that the constraint, "well-designed" encompasses a wide range of "treatments"). Smilansky's discussion of parental involvement is particularly valuable as this quite promising aspect of intervention programs seemed to be in danger of overselling as a result of the Bronfenbrenner review. 3/

There is no question that pessimism concerning the medium-term effects of pre-school intervention in IQ is well-founded. But

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1/ M. Smilansky,"Priorities in Education-Preschool Evidence and Conclusions, World Bank, 1977.

2/ U. Bronfenbrenner, "Is Early Intervention Effective?", mimeo, 1972.

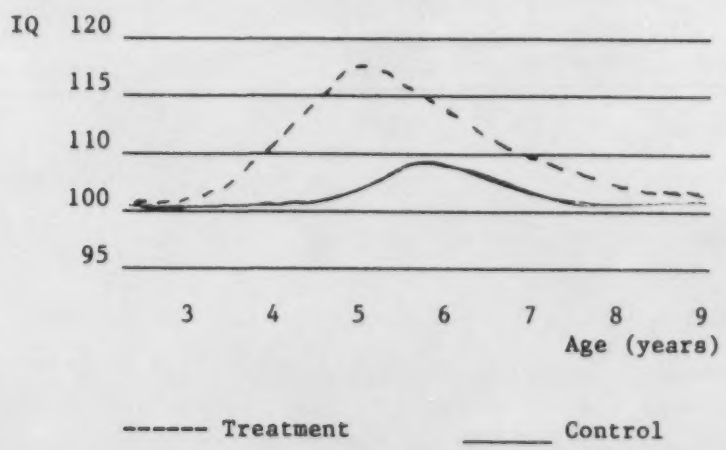
3 On this point, see also D. Weikart, "Parental Involvement Through Home Teaching," in Report 1974-75, High/Scope Educational Research Foundation, Ypsilanti, 1975.

before writing off any possibility of significantly augmenting the intellectual capacity of environmentally disadvantaged children, the following mitigating factors might be considered (as the thoughts of an economist wandering somewhat afield these observations should be appropriately discounted):

1. A critical consideration of the evaluation tools and the determination of appropriate criteria for success;
2. The adequacy of evidence concerning the appropriate period for intervention;
3. Two counter-instances of long-term intervention success.

The evaluation pattern for most intervention projects has followed standard experimental procedure. An experimental group(s) and a more or less carefully matched control group are followed through the treatment period and beyond, with longitudinal measurement of the selected outcome measures. The treatment group and controls are presumed to have an identical distribution of environments outside the intervention program and subsequently (in primary school). The standard pattern of results reviewed by Smilansky and others is shown in Figure 1.

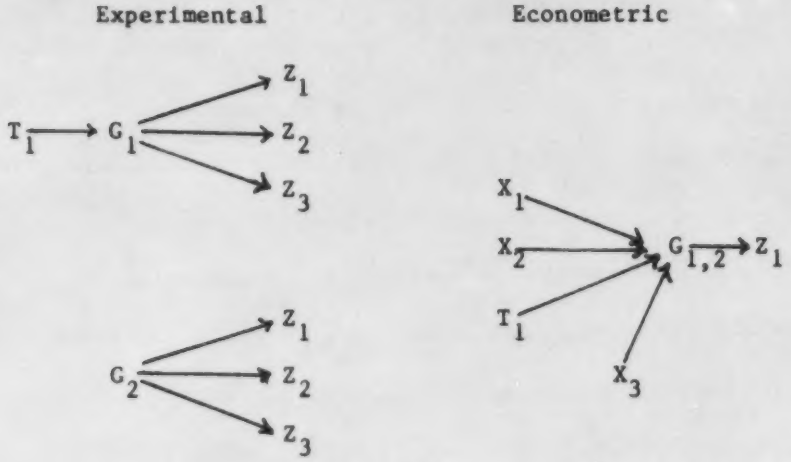
Figure 1



Typical Pre-school Intervention Experiment Results
(IQ units assumed initially at 100 for illustrative purposes)

Although formally similar, the methodology which has consistently generated this pattern of results may yield quite different implications than econometric methodology. The two approaches are illustrated in Figure 2: 1/

Figure 2



The experimentalist tries to match two groups on relevant characteristics and then focuses on a set of outcomes Z_i to look for significantly different outcomes. The econometrician typically would deal with the experimental treatment as one of the set of explanatory variables, and ask whether that particular variable was a significant predictor of Z_i (which is more often, though not necessarily, restricted to a single outcome). If the experimental and control groups, G_1 and G_2, are quite well matched on the set of explanatory variables then the two procedures should yield identical results. But suppose there is interaction between the treatment and the set of other explanatory variables;

1/ This distinction has been advanced by G. Orcutt in considering the methodology for elicting experimental effects from income maintenance experiments. In that context Orcutt has argued for a more experimental approach.

in these circumstances the experimental variable, T_1, would continue to be statistically significant, even though the set of outcome measures Z_i could not be significantly differentiated between G_1 and G_2. Possibilities along these lines suggest themselves in the early childhood intervention field. In all cases of the intervention projects reviewed by Smilansky, Bronfenbrenner and others, convergence of IQ scores occurred two, three or occasionally four years into the regular elementary school system. In the school environment children from disadvantaged backgrounds are not expected to perform well, especially if they come from a readily identifiable minority. The highly supportive, organized, and directed pre-school environment is left behind for an often hostile school environment that in practice if not intention reflects a quite different educational approach. Thus, an experience that is orienting for the control group is dis-orienting for the experimentals. Certainly this interpretation is consistent with a pattern of results summarized in Figure 1. Measurements of the schooling environment specific to the individual children (i.e., not based on classroom or school-wide means) would be required to satisfactorily test this hypothesis. Some indirect, supporting evidence may be found in the comparative curriculum program of the High/Scope Educational Research Foundation in which gains made initially in its cognitively-oriented pre-school curriculum are maintained when the same curriculum approach is continued in primary school. 1/

One early reaction to the predominantly negative assessments of intervention programs was to argue that intervention even at ages 3-4 occurred too late: infant programs were required. Smilansky is properly skeptical

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1/ Information on these programs was presented during a field visit to the High Scope Foundation in August 1976. No direct comparative evidence is available on this hypothesis, as the comparative curriculum program was not designed to follow-up varying pre-school experiences.

that these may be viewed as any more panacean than the pre-school age programs--though one may suspect that such skepticism should be grounded less in the merit of the respective programs than in sort of reasoning just presented, namely that "stimulated" infants are more likely to be repressed by subsequent "normal" environments than "control" infants. However, there is some reason to believe that fostering mother-infant interaction does have a broader beneficial impact which exceeds later pre-school intervention, because, as Smilansky notes, this sort of intervention can have significant effects beyond the cognitive domain. Evidence from both I. Gordon's mother education project in rural Florida and D. Lambrie's mother-infant intervention project in Michigan indicate that the level and quality of mother-infant interactions can be significantly increased through home visiting programs with paraprofessional staffing often by previously assisted mothers. 1/ Preliminary evidence from a similar project, now ongoing, among slum-dwellers in Bogota, Colombia, indicates that the fostering of such interactions may significantly improve the infants' anthropometric profiles relative to free or subsidized nutritional supplementation. (The intervention in this project is based on the Lambrie model). If this differential is confirmed and maintained, it has implications for traditional education approaches, for nutrition programming, and for family planning activities. To the extent that increased parent-child interaction is utility-creating for the parent and productive of a more successful, responsive child, one might expect an increase in the motivation to space children more optimally in order to facilitate such interaction. The increased time allocated by the parent to such interaction might be considered as a substitute with time which would have been allocated simply to the physical caring of another child. At any rate, these sorts of

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1/ I. Gordon, ed. Update, the First Ten Years of Life, proceedings of a conference held at the University of Florida, March, 1976.

potential benefits from infant-oriented intervention projects will not be picked up in the ordinary stream of IQ oriented evaluations. 1/

Other problems, acknowledged as well by Smilansky, stem from the almost complete dependence on IQ tests as evaluation instruments. Returning to the discussion of Section I, if the surest way to insure high inter-temporal correlations on an instrument designed to measure the theoretical construct, fixed intelligence, is to design a test that reflects the relatively constant environmental factors (in particular, home environment) then the eventual regression to the mean on this particular measure is perhaps less remarkable than the original experimental effect. If one adopts a developmental theory of intelligence, it is plausible that these particular aspects of cognitive intelligence augmented in early childhood and measured by IQ tests are again distributed normally by age 8 or 9 with the variance in that distribution accounted for at that age, largely by genetic and the more constant environmental factors. However, the relatively earlier attainment of specific cognitive skills may allow the child, with adequate support, to broaden his range of cognitive skills to include, for example, richness in written and verbal expression. There is evidence that as age increases treatment-control differences in IQ evaluations reflect different, more progressively difficult items. Furthermore the development of tests to measure language

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1/ On the psychoanalytic plane, E. Hagen argues in On the Theory of Social Change (The Dorsey Press, Homewood, Ill., 1962) that a revolutionary change in the patterns of intergenerational interaction is required to actuate economic change. Similar reasoning undoubtedly underlies Tanzania's program of day care activities though the process is there envisioned as a collective one. The stimulation of greater mother-infant interaction within existing familial structures might provide similar results for societies which are not collective-oriented. Though now admittedly simplistic on both the psychological and economic dimensions Hagen's work remains one of the few efforts to integrate these two important aspects of development.

richness indicates that this broadening of skills may be a more lasting result of cognitively and linguistically oriented pre-school and elementary school curricula. 1/

Finally, mention should be made of two exceptions to the generally negative evaluations of pre-school intervention. First, the Perry Pre-school Project begun in Ypsilanti, Michigan, in the early 1960s has perhaps the longest longitudinal span of any intervention project with the original cohort scheduled to graduate from high school in May, 1976. Although the pattern of IQ results is consistent with Figure 1, the treatment group has placed significantly fewer students in special education or retained them in grade as compared to the control group (17.5% as contrasted to 35%). Furthermore the treatment groups appear to have had significantly fewer dropouts. These two factors alone have been estimated to yield a 9% social rate of return to one year of intervention (this falls to less than 4% for two years of intervention). 2/ In another longer term follow-up, F. Palmer located the treatment group of an intervention program for 2-year old males in Harlem, New York City. At 10 years of age the treatment group had an IQ slightly over 100 (representing a significant 6 point advantage over non-treatment males) and they were reading at a level 3 months ahead of the New York City mean (which includes advantaged students and girls who at age 10 generally read 2-4 months ahead of boys). Palmer estimated conservatively that these black males from

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1/ Again the specific reference is to the High/Scope Foundation's efforts at developing "the Productive Language Assessment" which differentiates children on the basis of communicative richness and organizational complexity.

2/ "Summary of Longitudinal Findings from the Perry Preschool Project," High/Scope Educational Research Foundation, mimeo, 1975, and Weber C., Foser, P. and Weikart, D., "Costs and Benefits of Preschool Compensatory Education - An Economic Analysis of the Percy Project." University of Maryland, mimeo. 1976.

the treatment group were reading at least 6 months ahead of their black male peers. He also found significantly fewer of the treatment group held back in grade. 1/ The upshot of this admittedly piecemeal evidence as well as the doubts concerning the evaluation methodology would seem, at least, to raise the degree of ambiguity surrounding the verdict on early intervention in the United States.

What has been the experience of the less developed countries in setting or implementing policies affecting pre-school child development? In general few LDCs have accorded much recognition to the environment within which young children are expected to develop. Exceptions have occurred in countries where (i) the government wishes to foster a relatively rapid transformation of society, such as Tanzania or Peru (also, apparently, in revolutionary regimes such as China or Cuba), or (ii) where the degree of urbanization and/or labor force participation of urban women spur the demand for day care, with examples such as Chile, Colombia, Brazil, Ghana, Singapore, Iran and Egypt, or (iii) when rural labor practice and the demand for limited primary school slots coincide to generate a demand for pre-school education, as in Kenya. 2/

Even in countries which have reconized that the environment of young children might be the proper object for intervention policies, program design has been limited and implementation even more so. This hesitation is related to two basic, and as yet unresolved, issues for LDC policy makers:

1/ F. Palmer, "Has Compensatory Education Failed?," in Update, the First Ten Years of Life, University of Florida, 1976.

2/ Information on the programs and policies of several countries is contained in a UNICEF report National Studies on the Young Children, prepared as background material for the 1974 session of the UNICEF Executive Board.

(1) do pre-school outcomes translate into later effects on adult productivity, and (2) if such effects may be reasonably expected, how can pre-school outcomes be efficiently enhanced? In the case of the first question, little longitudinal evidence has yet surfaced which specifically relates to LDC environments. However, it is instructive to note that sources of data on this question became evident in the U.S. and Western Europe only after theoretical interest in the question had been articulated. The Taubman, Leibowitz and Hause studies discussed in Section I were all based on data whose existence was "rediscovered" and which was then updated for the longitudinal analysis. Similar possibilities may exist in many LDCs once researchers become attuned to the issues. 1/

Another possibility to develop a better understanding of the issues would be to follow up the school performance of children who have participated in the relatively few existing pre-school intervention projects. One of the best documented of such projects has been conducted with Ford Foundation support in Cali, Colombia, since 1968. Both nutritional supplementation and a cognitively-oriented pre-school curriculum were incorporated in the project. Initial results show that the combination of cognitive stimulation and nutritional supplementation produced ability outcomes from disadvantaged children which were not significantly different than those for children from relatively well-to-do backgrounds. Nutritional supplementation alone did not have such an effect. (Similar though less pronounced results were reported

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1/ For example, data collected by the Grace Department of Research, British-American Hospital in Peru over the last 15 years includes both schooling and medical outcomes for a large sample of children as well as detailed family background information. As these children will enter the labor force within the next few years, continued monitoring or re-interviewing in 5 years could result in an extremely rich longitudinal panel.

on anthropometric measures.) 1/ Plans are to extend the evaluation to primary school performance.

Other projects which are potential sources of data on the effects of pre-school intervention are included in the activities of UNICEF and, on a much more limited scale, of the Bernard Van Leer Foundation. 2/ In particular UNICEF has projects in Tanzania and Peru which have attempted to integrate specific pre-school education objectives within a rural development program. The project in Puno, Peru, utilizes a similar curriculum to that developed in Cali, while the Tanzania project is intended primarily to extend to selected ujama settlements day-care services along the lines of those already functioning elsewhere in the country. In neither case has any substantive research and evaluation component related specifically to effects on pre-school abilities and their connection to subsequent performance been included in the project design. If this were done, a body of evidence on the effects of intervention could be established and a significant sample followed longitudinally.

Similar research possibilities exist with numerous projects assisted by the Van Leer Foundation. All are of a pilot or experimental nature; but, based on published project descriptions, none include a research component well-focused on child outcomes and designed to inform policy-makers. The

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1/ H. McKay, A. McKay, L. Sinisterra, "Stimulation of Intellectual and Social Competence in Colombian Preschool Age Children Affected by the Multiple Deprevations of Depressed Urban Environments," Human Ecology Research Station, Cali, Colombia, September 1973.

2/ Relevant UNICEF projects and their general experience in this field were discussed during a visit to UNICEF headquarters in September 1976. Information on Van Leer Foundation projects is contained in their Newsletter, 17, Autumn, 1975.

scope of the Van Leer assisted projects is apparent from Table 3 which lists those funded as of late 1975. It is evident that considerable data on pre-school outcomes in a wide range of countries does or could exist as a result of the Van Leer projects. A few do have specific evaluation components and one describes research on the effectiveness of the pre-school programs. Nevertheless the opportunity clearly exists for research which could bring relevant evidence to the policy-maker on the question of relation between pre-school experience and subsequent performance, either in school or on the job.

Both the UNICEF and Van Leer projects also cover a broad range of intervention approaches; an operational evaluation of these could help answer the second, technological, question of how pre-school intervention can be made cost-effective given the necessary low child-adult ratios generally thought to be required. The Puno, Peru, project of UNICEF could again offer guidance on this question. Using the approach of the High/Scope Educational Research Foundation, which has now been extensively tested in both the United States and Latin America, a basic cognitive orientation to the curriculum is established emphasizing particular ability-generating activities. Within this framework, the interaction with the child can be undertaken by minimally trained (though well-supervised) personnel. Mothers and older children, in particular, become effective trainers either in home- or center-based activities. This approach has also been adopted in community day-care activities in Chile, which utilize low-cost structures or open space on community lands to house day-care activities which draw almost exclusively on paraprofessional personnel for staffing. In this case the paraprofessionals are often teen-agers who have no other focus of activity. There is reason to believe that

Table 3

BERNARD VAN LEER FOUNDATION PROJECTS
AFFECTING PRE-SCHOOL CHILDREN

Country	Coverage	Activities
Brazil	Pina, Pernambuco Sao Paulo	Pre-school Training Center Curriculum Development for Sao Paolo pre-school centers; research to assess effectiveness
Dominica	National	Teacher training and curriculum development with health and nutrition education component
Iran	4 locations 3 urban 1 rural	Early child education to be linked with adult education, materials development and training
Kenya	Nairobi	Curriculum development and teacher training for existing day care centers in Nairobi area
Malaysia	Kuala Lumpur	Curriculum Development Center and training center; mobile training unit; aimed at rural areas working through traditional child care institutions
Nigeria	Surulele District, Lagos	Community Education Center for preprimary and adult activities
Singapore	National	Teacher retraining for "unqualified" pre-school teachers
Trinidad and Tobago	Laventille, Port-of-Spain	Curriculum support and training; evaluation of pre-school program planned though University of West Indies
Venezuela	Caracas	Training of young people as aides to existing pre-school teachers; community approach

the High/Scope approach is one which can be implemented without extensive pre-service training programs, and no more than minimal physical facilities.

Numerous Van Leer assisted projects seem oriented toward integrating pre-school intervention with other community activites; however, this is often within the structure of a special development or training center functioning outside existing institutions. A further accommodation of pre-school intervention practices to traditional patterns of child care would seem to be one of the best ways of preserving those values and attitudes of traditional society that are often casualties of the modernizing process while at the same time augmenting pre-school outcomes. 2/ Adapting to traditional patterns also increases the likelihood of developing intervention programs at significantly lower costs than associated with "western" models. For example, in many cultures, responsibility for infant and toddler care traditionally falls on the cohort of 5-8 year olds within the extended family. However, as school attendance broadens to include greater proportions of girls, the availability of caretakers has declined. Increasingly infants are "cared for" by toddlers or taken to the fields. The demand for rural day-care centers has consequently increased, but as separate institutions these are expensive to staff and maintain, and receive little priority from governments burdened with expensive and often ill-adapted primary school systems. In such circumstances, the incorporation of day-care centers

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1/ This and previously mentioned information on the Bogota, Colombia, project information based on verbal reports elicited during a visit to High/Scope Foundation headquarters in Ypsilanti, Michigan, during August 1975.

2/ For perceptive empirical treatment of such values and attitudes and their relationship to child care practices see B. Whiting and J. Whiting, Children of Six Cultures, Harward University Press, Cambridge, 1974. In Two Worlds of Childhood, U. Bronfenbrenner discusses efforts to create or maintain desired social traits such as a sense of responsibility though specific child care practices.

into primary and secondary school activities offers numerous potential benefits. Care of pre-schoolers could be returned to a limited extent and under supportive supervision to the children who traditionally bore this responsibility. Possibilities would exist for basic, practical family life and population education (at least in secondary school). Such an arrangement would also facilitate the integration of pre-school and primary school curricula, which seems to be an essential condition for maintaining many of the cognitive gains which result from well-designed pre-school intervention projects.

More detailed analysis of family support or pre-school intervention program in LDCs is required before specific policy recommendations can be made. However, policies and programs identified and discussed here do seem to constitute a basis for a more thorough investigation of the technology of pre-school intervention and of its short- to medium-term effects. UNICEF, in particular, is in an ideal position to identify effective experimental or pilot projects from which a great deal more could be learned, given an effective research and evaluation effort.

Implications for the Bank

What conclusion for Bank involvement in the field of pre-school child development may be drawn from the studies reported here?

These studies were undertaken in the United States and Western Europe in an effort to single out and measure the hypothesized effect of ability on earnings. They demonstrate--variably--this effect as well as the effect on ability of family structure and economic environment. Comparable studies for LDC's do not exist because of the paucity of collected empirical evidence in these countries, where the patterns ahd magnitudes of the estimated relationships could be different from those of developed countries.

Consideration should be given to potential research inputs to existing pre-school projects or programs, perhaps on a collaborative basis with UNICEF. This could significantly increase our understanding of the effects of different pre-school environments in the LDC context. A better understanding the curriculums and institutional settings that seem to work for pre-school and early primary children could increase the complementarity between pre-school and primary education, thereby enhancing the productivity of the Bank's investments in the latter. Obviously the direct payoff to LDC-focused research on these questions will be some years hence.

What are the more immediate implications for the Bank? The results reported in Section II further validate the intimate connection between the status of the mother and the development of the child. The Bank has recognized that many development projects can have important effects on women through the provision or loss of income earning opportunities,

through effects on family structure, or through the inclusion or neglect of important services which may particularly affect women. It now seems apparent, that in its monitoring of these effects, the Bank should include the impact of changes in the status of women on outcomes for young children. This type of monitoring will also provide an important source of information on the relationship between development activities and family structure with a view toward the eventual development of project components which might address more directly problems in increasing the productive potential of young children in deprived LDC environments.

APPENDIX

In this appendix some additional comments are made on the studies by Taubman and Leibowitz 1/ and an extensive description of the Gary Income Maintenance sample data is provided with a detailed exposition of results.

It was noted that Taubman's investigation incorporates a biography variable which includes "prior education differences, grades in school and family SES." This composite is found to have a quite significant coefficient; but the relationship adds little to our understanding of ability formation as it is precisely among these variables that one would want to distinguish separate and/or interactive effects. Two other environmental variables have large significant coefficients: (i) Jewish upbringing is positively related to ability scores, and (ii) being raised by grandparents is negatively related to ability with a very large coefficient. The former is interesting in light of E. Hagan's hypothesis about cultural adaptations to social change. 2/ Hagan argues that families with a particular set of psychological characteristics will adapt themselves and their child-rearing practices much more readily to educational, economic and entrepreneurial goals congruent with rapid social and economic transformation particularly when under cultural stress. It may be argued that Jews in the twentieth century U.S. environment exemplify such characteristics. (Hagan develops related case studies in Burma, Indonesia, Colombia, among LDC's.) The detrimental effect of being raised by grandparents is not discussed by Taubman but could relate to a number of important factors: a poor health endowment of the child (if, for

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1/ P. Taubman, Sources of Inequality in Earnings, North Holland Press, Amsterdam, 1976 and A. Leibowitz, "Parental Inputs and Children's Achievement," Department of Family Medicine, University of Miami School of Medicine, mimeo, 1976.

2/ E. Hagan, On the Theory of Social Change, Dorsey Press, 1962.

example, the mother died in childbirth or related circumstances), culturally atypical family relationships, lower income and living standards (not unlikely in the pre-World War II environment in which Taubman's sample grew up) or reduced adult-child interaction with grandparents having numerous other responsibilities or interests. Certainly these are not exhaustive but the size of the coefficient (1.5 times the standard error of the dependent variable) suggests that some crucial effect in the child's background is being picked up.

Finally Taubman includes for control purposes two sets of ex post variables reflecting occupational choice factors and personal circumstances when entering the labor force. These cannot, of course, be interpreted in a directly causal manner, though they may reflect underlying traits which could have affected test performance. They may, in part, also measure subsequent outcomes determined by skills and abilities (thus reversing the causal flow assumed in the estimating equation). The first is a statistically significant association between higher ability scores and the dominance of financial over non-pecuniary motives in occupational choice. In another dimension, early marriage is negatively associated with ability. Finally self-employment and the perception of financial pressure when entering the labor force are associated with higher ability scores. Although such evidence is spotty, it does indicate some of the ways in which ability may be associated with motivations and entrepreneurial skills.

Based on her results, Leibowitz makes an interesting but perhaps overstated argument regarding the effect of family income on children's ability. First she contends that mothers' education reflects the productivity of time inputs to children rather than serving as a proxy for genetic

traits or family income since the entire effect is picked up by mothers' not fathers' education. This is true if one thought of education solely as proxy for genes and/or income; but it does not rule out interactive effects between mother's home productivity measured by education and unmeasured but correlated variables such as income. Leibowitz finds further evidence for no income effect on pre-school ability in the insignificance of coefficients on the presence of consumption durables such as color TV or hi-fis. But the presence of such goods cannot be regarded as an adequate proxy for income: surely the distribution of their possession does not resemble the distribution of income. Nor does Leibowitz report whether the greater effect of "goods," which showed up in her urban sample, extends beyond dishwashers and dryers to color TVs and hi-fis--to the extent that the urban sample is poorer, one might expect stronger income effects, assuming the production of abilities exhibits diminishing returns. Thus, in neither the Leibowitz nor Taubman ability production function estimates was there adequate treatment of income and its interaction with other home environment variables.

The data set which has been used by the present author to estimate a general pre-school ability function, may have somewhat closer affinity to the LDC context. As an adjunct to an Income Maintenance Experiment conducted by the United States Department of Health, Education and Welfare, a series of tests was administered to the pre-school children in a sub-sample of families participating in the experiment. The experiment enrolled families having earned incomes ranging from zero to about $15,000; all families were residents in four neighborhoods of Gary, Indiana and all were black. Approximately 65% of the sub-sample were female-headed families. To the extent that this sample reflects a low income group with marginal

connections to sources of status or economic growth in the national economy, its relative circumstances may not be too dissimilar from those faced by dwellers in the slums and peri-urban settlements of many LDC's. At any rate the sample is quite different from others used to estimate the effects and determinants of human capital investments in young children. 1/ In particular this investigation focuses on ability outcomes for those children for whom intervention programs have been, and presumably will continue to be, designed and thus may shed some light on the framework within which intervention must operate.

Information concerning the set of ability measures is summarized in Table A1. The classification of test by type is admittedly arbitrary since both cognitive and affective or social-emotional traits are clearly operative in all testing situations; however, within broad limits the predominant orientation of the test is listed first, followed by secondary factors. The vector of outcomes is considerably more diversified between cognitive and affective traits than previously reported investigations. Three of the tests are predominantly cognitive; two measure predominantly affective traits, while one relates primarily to visual-motor skills. All the tests exhibit significant developmental sensitivity, as measured by the percentage effect on the test score of one sample standard deviation in age. However, this age or developmental effect varies considerably: the Seguin Form Board Test having the

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1/ Taubman's sample all lay within the upper half of the ability distribution. The Leibowitz/Terman Sample (reported in Section I) similarly was quite biased toward high ability scorers; while the Leibowitz/Sesame data (discussed above in Section III) presumably included low ability scorers though no precise breakdown in presented.

greatest age effect and the Wechsler Pre-school and Primary Scale of Intelligence, a common IQ measure, showing the least age effect. 1/

A set of explanatory variables is presented in Table A2. These group into five categories and are motivated by the following considerations:

1. Child-Specific Variables: age, sex, child order and spacing - Age and sex are self-explanatory. These variables are introduced primarily as controls but they are of interest in their interaction with other policy related variables. Child order and child spacing have often been found to have a significant affect on ability measures similar to IQ. 2/
2. Test-Related Variables: Test order, test administrators - pre-school children are particularly susceptible to the abnormal environmental conditions inherent in most testing situations and are sensitive as well to the presence of the test administrator. 3/ Although the test environment was

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1/ The attenuated age effect on the WPSSI is due to some extent to the scoring procedure which averaged the number of completed items. Since questioning stops after two consecutive misses in the arithmetic, picture completion and block design sub-tests, there was some tendency for older children to complete more which would be imperfectly reflected in the average score.

2/ See in particular R. Zajene and G. Markus, "Birth Order and Intellectual Development", Psychological Review, in press, mimeo, 1975. They use data on a population cohort from the Netherlands to estimate a one parameter model relating abilities to family size stratifying by sibling position.

3/ E. Zigler, R. Abelson and V. Seitz, "Motivational Factors in the Performance of Economically Disadvantaged Children on the Peabody Picture Vocabulary Test," in Child Development, 1973, have documented significant test-environmental effects on a sample of Head Start pre-school children.

familiar to the subjects in this sample (tests were given at home), the order of the test, the training of the administrator and the time of day were all thought possibly to have significant effects on the test outcomes. Preliminary investigation eliminated time of day; but test order and training of the test administrator were retained in the analysis reported here.

3. Mother's Status: female head of the household, and mother's education. Almost all investigations of the production of childhood abilities find significant effects related to the education of the mother (though the interpretation of these effects is often confounded by the omitted variables problem). In this sample years of mother's education was found to be most effective when treated as a dichotomous variable based on the completion of twelve or more years of education. 1/ It is anticipated that a significant coefficient on this variable would reflect the mother's productivity in child rearing (though perhaps also serving as a proxy for genetic endowment). In the case of female headed families the anticipated effect is ambiguous. Female household heads may have sufficiently broader responsibilities or demands on their time so that effective interaction with children is significantly reduced. Similarly the climate of female-headed households that are in transition from previous two-parent households may be

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1/ Differences between this dummy variable and a continuous variable, mother's years of education, were not significant however.

disruptive to ability generation of either cognitive or affective traits. 1/ Female-headed households are a relatively common phenomenon in the rural areas of many LDC's as urban centers attract predominantly male immigrants who effectively abandon their rural families for long and uncertain periods of time. 2/ However, one might also expect positive effects to be attached to single-parenthood. If the status of the mother is consistently denigrated in two-parent families and the father takes little active part in child rearing, then the effectiveness of the mother's interaction with her children could be seriously undermined in traditional two-parent families. In the single parent household, the child, in contrast, is interacting with the very adult that he also perceives to have high status. This perception may significantly augment the effect of mother-child interaction on the acquisition of cognitive and affective traits.

4. Labor Force Participation and Unemployment - these dimensions of the family environment may significantly affect outcomes for children through their effect on stability and stress within the home (holding constant the effects of income) or they may operate primarily as indicators of the allocation of adult time between the workplace and the home. In the

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1/ This is not to deny that the single-parent household may not be a significant improvement over an unstable two-parent household. Indeed the comment is based on that premise.

2/ On the effects of such arrangements among families of rural Nyeri district in Kenya, see S. Abbot, "Full-time Farmers and Week-end Wives - An Analysis of Altering Conjugal Roles," Journal of Marriage and the Family, 1976, and the references therein.

former case one would expect a positive effect from labor force participation and a negative impact from unemployment. If the operative condition is time allocation the opposite effects would be anticipated.

5. Income Related Variables - the context of the present investigation allowed a much more detailed specification of family income than has usually been possible in such studies. Specifically average monthly income was grouped into categories of: (i) earned income, (ii) unearned income including all traditional welfare payments, and (iii) experimental transfer payments. The latter constitute the treatment in the experimental group; to the extent that any experimental effect is anticipated it should show up here. The design of the Income Maintenance Experiment also included a group of families with incomes considerably above the poverty level. In order to allow for non-linear effects in higher income earning families, the square of earned income was also included as an explanatory variable. Finally there may be good reason to believe that changes in income might have significant effects on the family environment. Families suffering losses in income may be expected to be under considerably greater stress as they struggle to maintain previous standards of consumption. Services previously purchased may have to be provided within the family, possibly reducing the interaction between parents and young children. Child oriented goods may also be sacrificed.

Reverse effects may reasonably be expected for increases in income. In an effort to capture some of these possibilities, the differences in average monthly income earned, unearned, and experimental, between the two years of the investigation period (1972 & 1973) were included as explanatory variables.

The results of this investigation are summarized in Table A3, A4 and A5. Table A3 summarizes regressions using various outcomes from the Seguin Form Test; Table A4 reports on four tests with strong affective components (Role Identification, Pre-school Inventory, School Readiness, and Self-Concept); and Table A5 reports on four subtests of the Wechsler Preschool and Primary Scale of Intelligence. Only coefficients are reported for which the probability exceeds 0.9 that the estimated value is significantly different than zero. This is a liberal criterion but is used to give a richer picture of the likely structure and reflects a belief that estimation in this field must be regarded as exploratory rather than confirmatory in character. In each table results are reported not only for the full test sample but also for various subsamples grouped on the mother's status variables, education and family head. In Table A4 regressions are also reported on the subsample of those children with positive responsiveness (i.e., children who refused to take the test were excluded in the estimation for this subsample).

The Seguin Form Board Test, the outcome measure of Table A3 measures cognitive traits through visual-motor dexterity. It can also be interpreted as an indicator of short-term learning by analyzing differences in the three trials that are usually given. Two dimensions of the test are recognized: (1) speed and (2) accuracy. Maturation has a highly significant effect on

both dimensions, but not on short-term learning ability. Both speed and accuracy are reduced by unfavorable testing conditions; but child specific characteristics other than age do not significantly affect performance (with the exception that close child spacing does reduce accuracy). Both effects of mother's status are significant; however, mother's education has only 35% to 40% of the impact that female-headed households have. Being in a female-headed household increases the speed of the child's response by as much as 16 months of additional maturation and the effect on accuracy is almost as great. Labor force participation of the family head positively affects both speed and accuracy of performance by an amount equivalent to 7-9 months maturation. Finally family income has similar positive effects: earned income on speed and unearned income on accuracy. On both test dimensions changes in both types of income have significant effects although the magnitudes are rather small.

On test outcomes intended to measure learning during the testing process, the pattern of results is spotty; but one important factor is the role of mother's status as a significant determinant of the child's learning during the test. This is particularly true in accounting for performance changes between the 1st and 2nd trials, on both speed and accuracy. There is no consistent relationships to other explanatory variables, though labor force participation is associated with poorer 2nd trial performance (in speed of test completion) and increases in experimental transfers seem to be significantly associated with test learning but the impact is small.

A grouping of observations into two pair of subsamples based on (i) mother's education or (ii) the presence of a female household head facilitates

an analysis of how mother's status interacts with the other explanatory variables. Analysis of covariance reveals that the single-parent/two-parent distinction results in significantly different overall relationships for estimating both speed and accuracy of child performance. However, the distinction is not maintained if a log-transformation of the speed score is used nor in all but one of test learning relationships. The high school/less-than-high school grouping produced significantly different overall relationships only in the dimension of test accuracy and changes in accuracy between trials.

Examining the size and pattern of significent coefficients between groups indicates some rather interesting differences. The effects of maturation on speed are much more pronounced in two-parent than in single parent families. 1/ Mother's high school education has a sizable and significant effect within two-parent families but none at all within single-parent families. This differentiation would seem to militate against a genetic interpretation to mother's education although it does not rule out a genetic-environmental interaction. Mother's education may therefore substitute, to some degree, for the increased status of the single parent mother (at least from the child's perspective). This effect of education may also be related to the enhanced maturation effects in two-parent families. Finally the income effects on speed of test completion are quite different: performance of children in two-parent families is positively related to experimental transfer payments (with rather sizable effects) while other unearned income

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1/ However these larger age coefficients do not significantly differ between groups in their effect on the distribution of scores because the standard deviation of the speed scores is similarly greater in the two-parent sub-sample.

provides a similar (though considerably smaller) effect in single-parent families. This may be interpreted as reflecting the benefits to traditional family structure from an income maintenance system as opposed to traditional welfare which is alleged to disrupt families and from which female-headed households are most likely to benefit. This distinction must be considered as quite tentative as it is not maintained in other Seguin outcome measures. In the accuracy outcomes one finds a differential effect of earned income in the two types of families, with earned income having a negative effect on performance accuracy of children in female-headed households. In this group labor force participation has a significant positive effect; if this is due to the enhanced status and security that labor force participation might provide the single parent, then the negative impact of earned income might reflect the reduced parent-child interaction that necessarily accompanies working by the single parent.

Turning to the education sub-groups the most consistent difference in coefficients among the Seguin outcomes is the very large positive effect that a female-headed household has on the performance of children whose mothers have less than 12 years of education. This effect is consistent with the interpretation of the two variables as reflecting different aspects of the mother's status. In other words, for the group of mothers with low educational status, the effect of that low status on child performance is mitigated by heading the household. There does not appear to be a consistent overall pattern to differences in coefficients on labor force or income variables between the two education categories, although in the speed of completion the entire effect of earned income seems to occur within the less

educated group which also exhibited a strong negative effect to employment. This suggests that earned income and regular employment may substitute for mother's education in the production of certain pre-school abilities. In the "test learning" outcomes there is some indication that labor force participation among less educated mothers significantly hinders performance. This result may stem both from the types of employment that are generally available to black women with low education and, since labor force participation refers to family head, a relative reduction in the status/productivity of less educated mothers when their spouses participate in the labor force. The effect may also simply reflect a reduction in time allocated to children with particular effects in this group due to a significantly lower rate of substitution for less educated mothers between the quantity and quality of time inputs.

Overall, this set of independent variables seems to generate respectable explanatory power for the set of pre-school outcome measures obtained from the Seguin Form Board Test. On the full sample, the explained variance in speed and accuracy outcomes averages 45%. In the sub-samples, the explanatory power increases from 50% to 70%. 1/ In the "test-learning" relationship age or maturation is not generally a significant determinant of performance and this reduces the explanatory power of the regressions (SEGDMI

1/ The log-transformation of the speed score (LSCT) seems preferable on grounds of a somewhat lower standard error of estimate than the untransformed score (SEGSCT). It also results in higher explained variance. It is not discussed in the text as the paterns of coefficients do not differ significantly. The implication of the log-transformation is that the coefficients may be interpreted as percentage effects.

to SEGDT2) to 12% to 35%. The effects of the selected explanatory variables also seem generally interpretable within the anticipated framework. 1/

Table 4 contains results based on a set of four tests all of which combine affective and cognitive components. The Pre-school Inventory (PSI) was designed to be primarily a cognitive evaluation measure for Head Start but it contains many elements that could best be classified as social-emotional. A role identification test (ROL) was designed specifically for this testing program by a staff member of the Income Maintenance Experiment. While this test has no standardized norms, it consists of relatively straightforward questions about home and community figures, familiar to most pre-schoolers. It is most safely viewed as a test of information and comprehension, which emphases roles that the child might be expected to identify. A widely used test for self-concept, the Brown Referent Scale, taps information not only on the child's perception of himself but also on his willingness to communicate emotions, and his comprehension of terminology. Finally another test developed for Head Start, Gumpgookies (GMP), is intended to measure school readiness through non-verbal responses.

The same groupings of observations are reported in Table 4 as in Table 3 with the addition of a "non-zero response" group. In each of these tests (PSI, ROL, BRN, GMP), ten to fifteen percent of the children simply refused to take the tests. As such passivity is itself a response but quite different from a wrong answer, non-reactions were scored zero,

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1/ One coefficient for which no ready interpretation is apparent is the positive effect of the number of "disabled" children reported by the mother. This may serve as a proxy for extra services or possibly extra income unreported in regular channels. It may also reflect greater awareness and sensitivity of the mother to child development. It was anticipated to have a negative effect reflecting increased stress within the household.

wrong answers one, and correct responses two. The "non-zero response" columns of Table A4 (3, 9, 15, 21) report regressions on observations excluding the non-responders.

Considering the results on the full sample for each of these four tests (columns 2, 8, 14, and 20 of Table 4), few generalizations emerge. On the tests having greater cognitive content, PSI and ROL, one consistent effect is the significant but modest impact of average monthly earned income. In each case the impact of an additional 100 dollars of monthly income is equivalent to 4-5 months in maturation. Additional monthly income of $500-$600 would be necessary to raise either score by its standard deviation. In both cases earned income is subject to a "topping off" effect with its square being negatively related to test performance (although monthly income of $800 in the PSI equation and $1,200 in the ROL equation would be required before the total earned income effect became negative). In the affective dominant tests (BRN, GMP) no consistent effects are found but labor force participation and unemployment do have significant positive and negative effects respectively on the school readiness test. This is consistent with an interpretation that labor force participation increases the stability of the household creating an environment which facilitates the "production" of abilities while unemployment has stress-creating effects. The labor force participation effect is substantial, approximating a standard deviation in the GMP test scores. The self-concept results show a negative effect to the number of children in the family while close spacing with the subsequent sibling has a counter-intuitive

positive effect (the spacing effect is reversed on the school readiness test).1/ Changes in incomes were also related to affective outcomes, with increases in earned income favorably affected the school readiness outcome. While these differences are presumed to be related to the income source, they may also indicate differential sensitivity to increases or decreases in income since earned income generally increased between the two years and unearned income decreased on average. Motivation for school may have been relatively more adversely affected by losses in income while self-concept responded relatively more to rising incomes.

For all four tests, the subsample of non-zero scores has a significantly different relationship to the set of explanatory variables than in the full sample (as indicated by the F-scores for the non-zero response samples). 2/ The set of non-zero PSI scores is significantly more affected by earned income. A $200 increment per month has an effect exceeding a standard deviation of the non-zero PSI scores; however, this enhanced income effect is not evident for the non-zero ROL scores. Another readily understandable result is the general reduction in the age coefficient in the non-zero samples. Maturation significantly increases the responsiveness of the child to strangers and this effect is picked up in the full sample age coefficients.

1/ Other counter-intuitive results include a negative effect of mother's education on the PSI score. This seems to be primarily in two-parent families and relates more to repsonsiveness that performance; but it still is not readily interpretable.

2/ These F-scores were computed using the Chow Test for equality between two sets of regression coefficients when the number of dependent variables equals or exceeds the number of additional (in this case, zero-valued) observations. See G. Chow, "Tests of Equality between Sets of Coefficients in Two Lienar Regressions," Econometria, 1960.

Turning to the analysis of covariance between the mother's status sub-groups (education and family head), the null hypothesis of overall homogeneity among the 8 pairs of groups cannot be rejected except in the distinction between single-parent/two-parent groups on the PSI score. The differential effects between these two groups hinge mainly on the enhanced effect of maturation in the two-parent families, which also support positive labor force participation and negative unemployment effects. In contrast, children in single parent families seem to respond quite positively in their PSI performance to earned income and experimental transfer payments (the latter are negatively associated with performance in the two parent families indicating that the income effects of the payments are not sufficient to overcome whatever other environmental effects may be associated with a family's receiving transfer payments). 1/ The differential effect of earned income is also evident among children having less well educated mothers as compared to children of better educated mothers for whom there is no such positive earned income effect.

One result consistent through all the tests reported in Table 4, including most of the sub-groups, is the negative effect of the change in experimental transfer payments between 1972 and 1973. Experimental payments were, by design, inversely related to earned income; but both earned income and experimental payments increased on average between the two years in this sample. Therefore this result presumably indicates that a child's acquisition

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1/ This negative effect contrasts with positive relative effects of experimental payments in facilitating beter performance on the Seguin Form Board.

of affective and/or cognitive traits is deferred by adverse economic circumstances which, in this sample at least, are proxied but not compensated by the increased experimental payments, nor are effects of these circumstances captured by declines in reported monthly earnings. 1/ It is also notable that, in general contrast to the Seguin results, these affective/cognitive tests seem to reflect no significant productivity effects atributable to mother's education. Demographic effects, birth order and spacing seem to play a greater role, though their size is relatively small.

In general these cognitive/affective tests are significantly related to the full sets of explanatory variables. The percentage of explained variance ranges from 36% to 49% on the full sample scores. These percentages are somewhat lower for the non-zero response groups. The standard errors estimated for the various sub-groups are consistently lower only on the PSI regressions. On the other tests the standard errors of the groups display no consistent pattern, though in some cases the variance explained within particular subgroups increases markedly. For example, on the affective test scores (BRN, GMP), the set of explanatory variables considered as a whole seems to perform noticeably better in the two-parent and mother educated groups. Only on the role identification score does the whole set of variables perform best on the group having less well educated mothers.

The outcome or ability measures reported in Table A5 are subtests of the Wechsler Preschool and Primary Scale of Intelligence, a widely used and

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1/ This argument is based on an apparent reverse ratchet effect in that increases in monthly earnings between 1972 and 1973 (which predominate in this sample) do not have a significant positive effect on performance but decreases in earnings which are picked up in increased experimental transfer payments do have a significant negative impact on child performance.

"reliable" IQ type test for young children. Four subtests were used in this testing program: (i) arithmetic, (ii) block design, (iii) comprehension and (iv) picture completion. Since these four scales are normally considered as only a part of the overall IQ measure and they tap quite different skills, they are here analyzed separately. Also two different scores are reported: (i) the average score for a particular subtest (columns 2-21 of Table A5) and (ii) the raw score (columns 22-41). In the administration of some WPPSI subtests questioning stops after two succesive failures (arithmetic, block design, picture completion), therefore the average score will not in general pick up a more sustained performance. If answering more questions is systematically related to any of the explanatory variables (such as age), this should be reflected in the regression results on the raw scores. Tests were also made on the non-zero response group of observations but in no case was it possible to reject the null hypothesis that the zero-response observations were not significantly and differently related to the set of explanatory variables.

Accross the full-sample results on all four sub-tests, test conditions, child specific variables, and the change in monthly earned income are consistently significant. In contrast to all other tests, these IQ related scores are consistently reduced as the WPPSI was given farther toward the end of a sequence of tests. Interestingly, child's performance seems to be positively related to his birth order, a finding contrary to other studies (see footnote 5). However, the child spacing variable performs as predicted with consistent negative effects of close spacing on all sub-test scores. The consistent income effect stems from the change in monthly average earned

income between 1972 and 1973, indicating that, at least for this low income sample IQ is more affected by the growth or decline of income than by its level. This suggests that expenditures on children or on goods affecting the environment of children may enhance their performance and that such expenditures are made out of an increases in income from relatively low levels (or, equivalently, that such expenditures are among the first to be sacrificed when income falls). Finally on the block design component the presence of the child in a single-parent family has a significant and large impact on his performance. As this is the one WPPSI component stressing visual-motor skills, a result consistent with the earlier Seguin test scores is reassuring. This general pattern of results is maintained among the raw scores with the addition of monthly earned income as a significant determinant on both comprehension and block design scores with each $100 of monthly earned income equivalent to 5-6 months additional maturation and contributing 20% to 25% of a standard deviation to the raw scores. It is also worth noting that maturation does not contribute significantly to the arithmetic sub-test score (this is true whether the average or raw scores are used). This may indicate a significant innate component to mathematical abilities which behaves analogously to the maturational components of other abilities. If this be the case, it is interesting to note that no other variable, such as mother's education, seems to serve as a proxy for this genetic effect.

Mother's status variables have (with the single exception noted above) no significant impact on any of the sub-tests. Thus it is not surprising that, in general, the observations grouped by mother's education, or female family head, cannot be statistically distinguished from the pooled

observations. One exception is the high school/less-than-high school grouping of the picture completion scores. In this case the two patterns of coefficients are quite different with single-parenthood enhancing the performance of children of the better educated mothers (in contrast to other results reported above). The child spacing and birth orders effects are also significantly stronger in the two-parent families, while maturation seems to influence the scores of children only in the single-parent families. The same single-parent effect is very pronounced among children of better educated mothers on the block design sub-test (on this test, the reciprocal effect of mother's high school education on children in single parent families is also significant). Why these two sources of mother's status should complement each other in these instances when on other outcome measures they functioned as substitutes has not yet been resolved.

Surveying the overall significance of the WPPSI regressions, it is apparent that the explanatory power of the full set of variables is somewhat less on these IQ related tests than on the affective/cognitive tests reported in Table A4. However, only one regression (arithmetic raw scores) has an F-value too low for rejection of the null hypothesis of no significant overall relationship (not reported in Table 5). The standard error of estimates within the groups of observations grouped by mother's high school education are significantly lower (with correspondingly higher percentages of explained variance). This tendency is more marked than on previous tests (probably reflecting the interaction of single-parenthood and mother's education), while in contrast to other tests, the set of variables treated here seems to explain

more of the variance in WPPSI sub-test scores among children of single-parent as opposed to two-parent families.

What conclusions may be drawn from this investigation of the production of different abilities in young children?

The first and most basic point is that even within rather narrowly defined socio-economic (poor to lower-middle income blacks) strata family characteristics which can be statistically characterized do significantly affect outcomes for pre-school children. The second point would seem to be that the status of the mother does significantly affect the family's productivity in producing abilities in children. The status of the mother reflects not just her education, but also her position as head or spouse within the family and her participation within the labor force. Further, these three factors and family income, both earned and unearned, interact in a rather complex fashion. Controlling for these status variables, one may generalize that family income has a significant impact on abilities in a sample of predominantly low-income black American children. There is some reason to believe that for some abilities (perhaps including IQ and some affective traits) the significance of income or changes in income dominates the effect of mother's education at least within the ranges of income and education covered by the present sample (incomes less than $15,000 a year and education of high school or less). There is also evidence that income plays a more significant role in families in which the mother is less well-educated. Finally demographic effects are mixed: there does seem to be a general detrimental effct to close child spacing on ability generation particularly in two-parent families or families having a relatively more educated mother.

However, there does not appear to be a consistent pattern to the effects of birth order. It is worth noting that these child specific variables (including age) do interact with mother's education and other measures of family status. Thus test scores standardized by age, for example, may fail to accurately reflect environmental influences.

Table A.1

PRE-SCHOOL ABILITY MEASURES

TESTS USED	AGE RANGE (months)	SAMPLE SIZE	TYPE	MEAN SCORE (standard deviation)	AGE EFFECT[1/] (percent)	REMARKS
Role Identification Questionnaire	30 - 72	143	Cognitive Affective	1.594 (0.976)	28.1	20 Repeats, 26 Siblings, 97 Families; Non-Standardized Test
Seguin Form Test	31 - 72	148	Motor-Manipulative Cognitive	55.8 (43.9) 11.3 (19.5)	45.1 Time 79.2 Mistakes	16 Repeats, 29 Siblings, 103 Families
Cooperative Pre-School Inventory	43 - 54 61 - 66	81	Cognitive Affective	1.188 (0.643)	21.9	9 Repeats, 7 Siblings, 65 Families
Brown Referent Scale	37 - 42 49 - 54 61 - 78	81	Affective	1.464 (0.706)	23.3	1 Repeat, 11 Siblings, 69 Families
Gumpgookies (School Readiness Scale)	43 - 48 55 - 66 73 - 78	71	Affective Cognitive	1.356 (0.639)	18.7	10 Siblings, 61 Families
Wechsler Preschool and Primary Scale of Intelligence (SPPSI)	49 - 72	105	Cognitive	1.390 (0.372) 1.467 (0.364) 1.780 (0.695) 1.649 (0.596)	6.3 Picture Completion 2.3 Arithmetic 8.8 Block Design 13.9 Comprehension	6 Repeats, 14 Siblings, 85 Families

1/ Calculated as $(\hat{b}_{age}^{i} \hat{s}_{age}^{i}) / m_{score}^{i}$ indicating the percentage effect on the score of the mean individual one standard deviation removed from the mean age of the sub-sample who took test i.

TABLE A.2

EXPLANATORY VARIABLES - DESCRIPTION & DISTRIBUTION

VARIABLE	UNITS OR RANGE	MEAN (Standard Deviation)	DESCRIPTION
AGE	Months	38.2 (27.64)	Age means on various tests obviously differ.
TESTORD	1 - 5	~ 2.78 (1.48)	Position of particular test in the sequence given. Range from 1 to 5.
TESTADM	0,1	~ .37	Tests were administered by two sets of administrators; one was extensively trained, the other was not (1 = less well trained).
KDORDER	1 - 9	~ 2.81 (1.94)	Position of child in family.
NKDS	1 - 14	4.53 (2.71)	Number of children in the family, calculated as the remainder after the number of parents is subtracted from resident family size, so includes other permanently resident non-family children and excludes non-resident children.
NDC	1 - 3	0.27 (0.61)	Number of "disabled" children reported by mother.
KDSEX	0,1	0.48	Sex of child (1 = boy).
KDGAP	0 - 1	0.26 (0.27)	A measure of the closeness of spacing between the subject and his next oldest sibling; 0 - only child, 1 = gap of 10 months.
SGLPAR	0,1	0.65	1 = Single parent family, all are female headed.
LFPR	0,1	0.39	1 = Family head participated in labor force at some time in two years during which testing occurred.
UNEMP	0 - 8	0.65 (0.97)	Measures the incidence of unemployment of either the primary or secondary worker within the family during the two years in which testing occurred (1972-73).
MOMHS	0,1	0.40	1 = mother attained twelve or more years of schooling.

Table A.3

SIGNIFICANT COEFFICIENTS ON MEASURES DERIVED FROM THE SEGUIN FORM BOARD TEST

Outcome Measures[1]

Exogenous Variables p(p <.1)	SEGSCT Full Sample $\hat{s}$ = 44.41 [2]	SEGSCT SGLPAR $\hat{s}$ = 33.69	SEGSCT TWOPAR $\hat{s}$ = 55.44	SEGSCT MOMHS $\hat{s}$ = 38.52	SEGSCT MOMGS $\hat{s}$ = 48.52	LSCT Full Sample $\hat{s}$ = .573	LSCT SGLPAR $\hat{s}$ = .54
AGE	-2.434	-1.877	-2.928	-2.118	-2.516	-.036	-.033
TESTORD	3.347		11.969		6.427	.046	
TESTADM	4.661					.105	
KDORD			6.392				
KDSEX							
KDGAP		4.865	-50.257			.100	.095
SGLPAR	-32.120				-53.300	-.342	
NDC	-9.962		-14.603		-16.220		
MOMHS	-12.356		-32.131			-.130	
LFPR	-18.772			-29.336			
UNEMP					8.869		
MNEY	-8.341				-18.402		
MNEYSQ					2.033		
MNUY		-9.593		-16.996		-.160	-.122
MNTPY			-20.456				
DMNEY	-3.354				-8.240	-.	
DMNUY	-11.473	-12.046		-18.297	-10.898	-.173	-.136
DMNTP			-14.486				
TESTRPT	-13.885					-.233	-3.86
DM1/DM1 [3]							
R^2	.44	.51	.62	.60	.52	.57	.58
Standard error of estimate	35.400	26.600	40.610	28.800	37.810	.40	.39
Sum of Squared Residuals		44590	70915	34030	92941		9.790
F (test of covariance)		2.53 (p <.01)		1.46 (p >.05)			

Note: Lower scores indicate better performance. Therefore negative coefficients indicate positive ability effects.

1/ Three trials with the Form Board are given. SEGSCT is the fastest time of the three trials. LSCT is a natural log transformation of SCT. SEGSCM is the total mistakes for all trials. SEGDM1 is the difference in mistakes between trials 1 and 2. SEGDM2 is the difference in mistakes between trials 2 and 3. SEGDT1 is the difference in time between trials 1 and 2. SEGDM2 is the difference in time between trials 2 and 3.

2/ $\hat{s}$ is a sample standard deviation of dependent variables.

3/ SEGDT1 and SEGDM1 were used as control variables in regressions on SEGDT2 and SEGDM2 respectively.

TABLE A.3 cont.

LSCT TWO PAR	LSCT MOM ≥ HS	LSCT MOM < HS	SEGSCM FULL SAMPLE	SEGSCM SGLPAR	SEGSCM TWOPAR	SEGSCM MOM ≥ HS	SEGSCM MOM ≤ HS
.61	.54	.59	15.23	13.34	17.44	16.12	14.66
-.037	-.034	-.035	-.816	-.662	-.978	-.721	-.790
.102		.085	.060			-2.230	1.364
.201				8.400	9.096		7.875
.062				-2.535	2.324		
-.445		.123	1.726				1.762
		-.567	-9.482				-15.335
		-.131		-12.380			
-.258			-3.444				
			-5.520	-8.638	-11.898	-9.532	
		-.277		+6.502			
		.025		-1.176			
		-.134	-4.301			-9.600	-4.026
-.233						-3.890	
-.054		-.102	-1.349				-2.518
		-.140	-5.389	-5.150	-5.618	-10.791	-5.239
		-.231		-6.837			-6.056
.70	.68	.62	.46	.51	.64	.59	.52
.40	.37	.41	11.91	10.59	12.43	12.40	11.51
7.034	5.551	11.115		6653	7071	6341	8614
1.47 (p > .05)		1.25 (p > .05)			4.96 (p < .01)		2.92 (p < .01)

Note: Lower scores indicate better performance. Therefore negative coefficients indicate positive ability effects.

TABLE A.3 cont.

SEGDM1 FS	SEGDM1 SGL	SEGDM1 TWO	SEGDM1 ≥HS	SEGDM1 <HS	SEGDM2 FS	SEGDM2 SGL	SEGDM2 TWO
3.818	3.971	3.613	3.909	3.667	3.738	3.976	3.415
					.075	.098	
					-.420		
							-.638
		-3.257					3.530
				-1.078			
-2.075	-2.560	-2.660				1.403	-3.295
2.893		5.297		3.850			
		-1.020	-1.359	1.353			
				-.285		.336	
							1.443
							-.282
				-1.099			-1.497
-.809	-1.567			-1.187			
					-.427	-.560	-.185
.18	.23	.31	.27	.35	.33	.50	.52
3.69	3.95	3.559	3.992	3.337	3.288	3.187	2.84
	983	544	653	724		629	339
		.63 (p > .05)		1.69 (p ~ .05)			2.19 (p < .01)

Note: Lower scores indicate better performance. Therefore negative coefficients indicate positive ability effects.

TABLE A.3 cont.

SEGDM2 ≥ HS	SEGDM2 < HS	SEGDT1 FS	SEGDT1 SGL	SEGDT1 TWO	SEGDT1 ≥ HS	SEGDT1 < HS	SEGDT2 FS
2.567	4.397	43.09	45.99	36.68	35.44	48.74	36.74
	.083						.490
	-.628						
1.275		10.821		24.984	13.090		
		-5.628	-7.619				
	-1.299						
	-2.917						-32.344
	-1.62						
		-15.392	-18.36				
						41.61	
	-.74						
				-15.443			
1.382				1.091			
				-21.908			
	-.328						
	-1.065	-8.279		10.719			
-.204	-.701						-.34525
.52	.51	.14	.14	.25	.18	.12	.33
2.153	3.501	42.69	48.23	41.96	38.32	51.43	31.79
185	784		146590	75738	60234	171984	
2.10 (p~.01)			.74 (p>.05)		.54		

Note: Lower scores indicate better performance. Therefore negative coefficients indicate positive ability effects.

TABLE A.3 cont.

SEGDT2 SGL $\hat{s}$ = 36.38	SEGDT2 TWO $\hat{s}$ = 36.68	SEGDT2 ≥ HS $\hat{s}$ = 30.76	SEGDT2 < HS $\hat{s}$ = 40.65
.941			
	-3.770		
	36.771		
			-52.88
28.87			
21.63	-21.626		
		-9.445	
		.763	
	-4.759	-3.737	
	-14.004		
- .436			-.439
.48	.51	.28	.56
29.86	30.8	31.57	30.60
55294	39860	39868	59961
2.86 (p<.01)		1.55 (p>.05)	

Note: Lower scores indicate better performance. Therefore negative coefficients indicate positive ability effects.

Table A.4

SIGNIFICANT COEFFICIENTS IN FOUR PRESCHOOL OUTCOME MEASURES: PRESCHOOL INVENTORY (PSI), A ROLE IDENTIFICATION MEASURE (ROL), THE BROWN SELF-CONCEPT SCALE (BRN) AND THE GUMPGOOKIES SCHOOL READINESS SCALE (GMP)

Exogenous Variables ($p < .1$)	Outcome Measures: PSISCO Full Sample $\hat{s}$ = .643 1/	PSISCO Non-Zero SCO $\hat{s}$ = .468	PSISCO SGLPAR $\hat{s}$ = .637	PSI TWO PAR $\hat{s}$ = .6531	PSI ≥ HS $\hat{s}$ = .660	PSI <HS .637	ROL Full Sample $\hat{s}$ = .97
AGE	.032	.014	.021	.053	.036	.019	.040
TESTORD		.079	.109				
TESTADM							
KDORD	-.112		-.192		-.277	-.105	
KDSEX				-.508	.882	-.268	
KDGAP			.647				
SGLPAR							
NDC		-.191	1.26				
MOMHS	-.206			-.436			
LFPR				.951		-.689	
UNEMP				-.369	.234		
MNEY	.163	.256	.335			.682	.181
MNEYSQ	-.026	-.033				-.091	-.014
MNUY						-.178	
MNTFY			.197	-.338			
DMNEY					-.121		.068
DMNUY						-.211	
DMNTP	-.319	-.348	-.575	-.514		-.436	
NKDS							
R^2	.496	.470	.72	.72	.74	.63	.36
Standard Error of Estimate	.522	.399	.434	.499	.494	.480	.832
Sum of Squared Residuals	16.65	7.99	4.899	4.088	3.424	7.152	86.68
F (test of covariance)		4.92	2.13 ($p < .05$)		1.67 ($p > .05$)		

1/ $\hat{s}$ is a sample standard deviation of dependent variables.

TABLE A.4 cont.

ROL Non-Zero SCO $\hat{s}$ = .686	ROL SGLPAR $\hat{s}$ = .938	ROL TWO PAR $\hat{s}$ = 1.038	ROL $\geq$ HS $\hat{s}$=1.015	ROL < HS $\hat{s}$ =.948	BROWN Full Sample $\hat{s}$ = .706	BROWN Non-Zero SCO $\hat{s}$ = .369	BROWN SGLPAR $\hat{s}$ = .671
.032	.046	.035	.029	.042	.031	.010	.024
			-.222				
			.782				
				-.172	.619		.694
			-.897	.637			-.786
			.317				.183
.152				.383			
				-.073			-.304
	.313		.258				
	-.181	.118		.100	.087	.097	
	-.372				-.217		-.224
	.915				-.104		
.42	.46	.45	.40	.55	.48	.32	.60
.56	.76	.906	.902	.699	.574	.351	.523
31.54	39.57	33.68	36.65	32.30	20.47	6.165	7.932
5.44	1.1 (p>.05)		1.52 (p>.05)		11.02		

TABLE A.4 cont.

BROWN TWO PAR $\hat{s}$ = .756	BROWN ≥ HS .774	BROWN < HS .662	GMP Full Sample $\hat{s}$ = .639	GMP Non-Zero SCO $\hat{s}$ = .398	GMP SGLPAR $\hat{s}$ = 671	GMP TWO PAR .602	GMP ≥ HS .522	GMP < HS .688
.047	.044	.023	.018	.015		.209	.047	
.278						-.230		
		-.314				.482		
	1.137		-.207		-.245	-.779		-.300
	-1.157							
					.543			
			.611					1.490
	.220		-.141			-.534		
	-.347							-.366
	.028							.021
					.208	1.779		
			.143			-.764		.230
.134						-.156		
			.263			1.622		
-.376	-.370	-.270		-.174		-.483	-.336	-.241
-.246						.260		
.59	.67	.45	.36	.42	.44	.69	.72	.40
.671	.610	.594	.584	.354	.652	.486	.448	.652
7.675	5.962	11.322	18.10	5.53	9.803	3.310	1.808	12.76
.90 (p>.05)		.60 (p>.05)		6.30		.86 (p>.05)		.53 (p>.05)

Table A.5

SIGNIFICANT COEFFICIENTS ON SUB-TEST OF
"WECHSLER PRESCHOOL AND PRIMARY SCALE OF INTELLIGENCE"

Outcome Measures[1]

Exogenous Variables ($p<.1$)	WPSCOA Full Sample $\hat{s}$ = .364 [2]	SCOA SGLPAR $\hat{s}$ =.370	SCOA TWOPAR $\hat{s}$ =.359	SCOA MOMHA $\hat{s}$ =.369	SCOA MOMGS $\hat{s}$ =.363	WPSCOB Full Sample $\hat{s}$ =.695	SCOB SGLPAR s = .655	SCOB TWOPAR s = .742
AGE						.021	.022	.033
TESTORD	-.051		-.109	-.077		-.105	-.077	
TESTADM	-.104							
KDORD	.035			.193		.081		.146
KDSEX			-.226				-.328	
KDGAP	-.107	-.113			-.122	-.168	-.200	
SGLPAR						.553		
NDC								-.295
MOMHS							.414	
LFPR							.772	
UNEMP								
MNEY								
MNEYSQ							.112	
MNUY								
MNTPY								
DMNEY	.045		.052	.064		.061		.110
DMNUY								
DMNTP				-.152				
$\bar{R}^2$	.28	.41	.47	.45	.38	.30	.47	.53
Standard Error of Estimate	.338	.334	.335	.357	.333	.635	.560	.654
Sum of Squared Residuals	9.862	4.922	2.82	3.067	4.996	34.70	13.82	10.71
F (test of covariance)		1.048			.86	.12		

1/ Four subtests of the WPPSI were used in the testing program: Arithmetic, Block Design, Comprehension and Picture Completion. Separate estimates were made for the average scores (WPSCOA, WPSCOB, WPSCOC, and WPSCOP) and for the raw scores (ARITH, BLOCKS, COMPRE PICTR).

2/ $\hat{s}$ is a sample standard deviation of dependent variables.

TABLE A.5 cont.

SCOB MOMHS .752	SCOB MOM HS .659	WPSCOC Full Sample .596	SCOC SGLPAR .587	SCOC TWO PAR .616	SCOC MOMHS .617	SCOC MOM HS .586
.027	.022	.027	.030		.031	.026
-.139		-.070				-.085
.396					.371	
.436					.214	
			-.277			-.164
-.914	-.198	-.097	-.140			-.157
1.215						
-.441			.228			
			.323			
					.019	
			-.156			
.091		.069		.116		
				-.333		
.66	.32	.37	.58	.51	.62	.46
.572	.636	.518	.443	.55	.493	.502
7.878	18.22	23.11	8.64	7.70	5.84	11.36
1.27		.51	1.658		1.334	

TABLE A.5 cont.

WPSCOP Full Sample .3723	SCOP SGLPAR .324	SCOP TWOPAR .435	SCOP MOMHS .434	SCOP MOM<HS .328	ARITH FS $\hat{s}$ = .92	ARITH SGLPAR 4.23	ARITH TWOPAR 3.45
.009	.012			.010		.123	
-.034			-.106				-.956
.044	.047		.249		.451		.701
-.148	-.124		-.597	-.128			
			.644				
-.115		-.150	-.379				
	.162						
							-4.62
	-.212						
	.084						
	-.077		.134			-.156	
.055		.087	.076				
		-.167	-.221				
.34	.59	.48	.64	.46	.16	.24	.43
.331	.243	.406	.337	.282	3.93	4.32	3.36
9.423	2.614	4.124	2.732	3.600	1331	822	283
1.26	1.46		1.89(p .05)			.78	

TABLE A.5 cont.

ARITH MOMHS 3.273	ARITH MOM<HS 3.920	BLOCKS FS $\hat{s}$=4.77	BLOCKS SGLPAR 4.63	BLOCKS TWOPAR 4.95	BLOCKS MOMHS 5.461	BLOCKS MOM<HS 4.305	COMPRE FS $\hat{s}$=7.06	COMPRE SGLPAR 7.22
	.147	.203	.188	.336	.263	.203	.440	.468
					3.068			
2.15				.721	2.421			
				2.861	3.274			-3.367
					-6.593			
		3.893						
			2.81					4.118
			2.40					3.378
			5.13				-4.110	
	-.843		-1.01					
	-.124	1.109						
			.812					
								-2.154
				.621				
								-1.967
				-1.77				
.40	.29	.28	.38	.53	.58	.24	.41	.60
4.011	3.858	4.451	4.27	4.40	4.58	4.385	5.957	5.35
386.2	669.9	1704	805.9	484.9	503.91	865.6	3052	1261
1.015		.98		1.52		.93	.63	1.187

TABLE A.5 cont.

COMPRE TWOPAR 6.90	COMPRE MOMHS 7.884	COMPRE MOM HS 6.519	PICTR FS $\hat{s}$=5.65	PICTR SGLPAR 5.51	PICTR TWOPAR 5.87	PICTR MOMHS 5.933	PICTR MOM HS 5.453
.328	.545	.401	.253	.294	.236	.290	.229
	5.970			2.213			
	2.070		.430	.974		2.298	
		-2.113	-1.071			-5.968	-.969
						7.866	7.866
	3.702					-2.715	
				3.162			
				-.937			
	-2.914	1.778	1.534				1.573
				1.25	5.127		-.140
.838			.546		.833	.785	
					4.301		
-3.09					-2.709		
.45	.70	.47	.28	.52	.36	.36	.29
6.62	5.634	5.55	5.25	4.45	5.83	5.83	5.262
1096	761.8	1389.6	2374	873.0	920.6	920.6	1301
	1.60		.87		1.32		

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